

Daily report

17-05-2020

Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries

Foreword

The present report aims to provide a comprehensive picture of the **pandemic situation of COVID-19** in the EU countries, and to be able to foresee the situation in the next coming days.

We employ an **empirical model**, verified with the evolution of the number of confirmed cases in previous countries where the epidemic is close to conclude, including all provinces of China. The model does not pretend to interpret the causes of the evolution of the cases but to permit the **evaluation of the quality of control measures made in each state** and a **short-term prediction of trends**. Note, however, that the effects of the measures' control that start on a given day are not observed until approximately 7-10 days later.

The model and predictions are based on two parameters that are daily fitted to available data:

- ✓ α : the velocity at which spreading specific rate slows down; the higher the value, the better the control.
- ✓ K : the final number of expected cumulated cases, which cannot be evaluated at the initial stages because growth is still exponential.

We show an individual report with 8 graphs and a table with the **short-term predictions** for different countries and regions. We are adjusting the model to **countries and regions** with at least 4 days with more than 100 confirmed cases and a current load over 200 cases. The **predicted period** of a country depends on the number of datapoints over this 100 cases threshold, and is of 5 days for those that have reported more than 100 cumulated cases for 10 consecutive days or more. For short-term predictions, we assign higher weight to last 3 points in the fittings, so that changes are rapidly captured by the model. The whole methodology employed in the inform is explained in the last pages of this document.

In addition to the individual reports, the reader will find an initial dashboard with a brief analysis of the situation in EU-EFTA-UK countries, some summary figures and tables as well as **long-term predictions** for some of them, when possible. These long-term predictions are evaluated without different weights to datapoints. We also discuss a specific issue every day.

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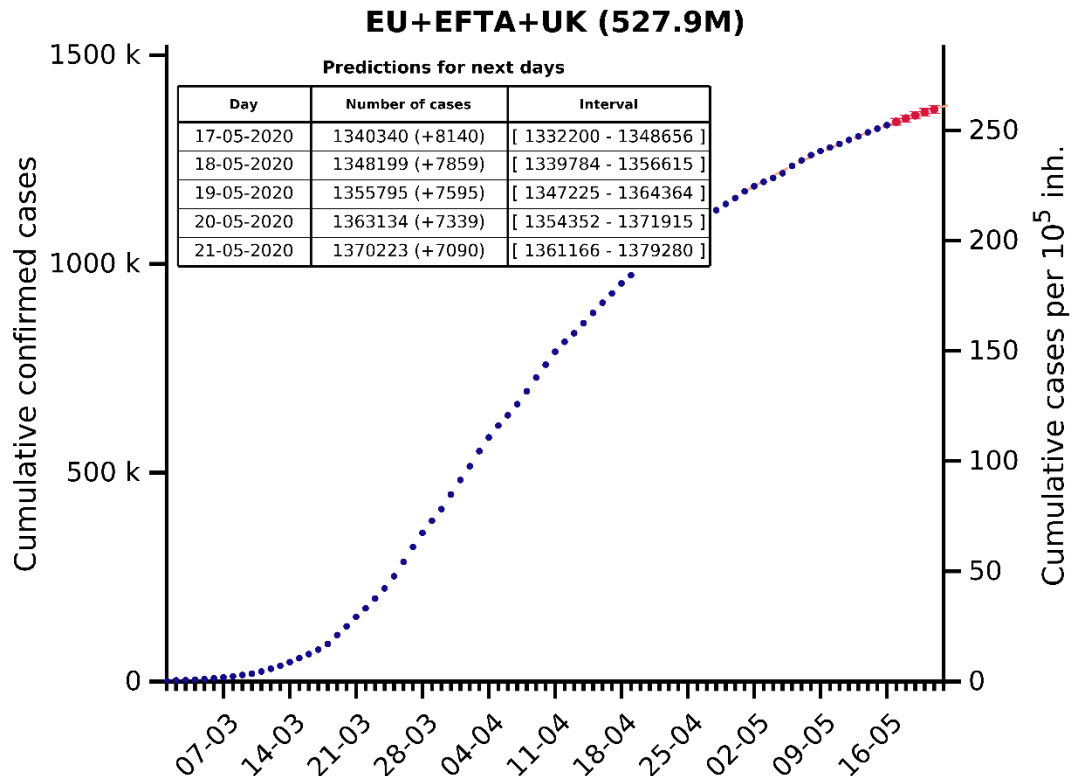
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(0) Executive summary – Dashboard

Weekend short version

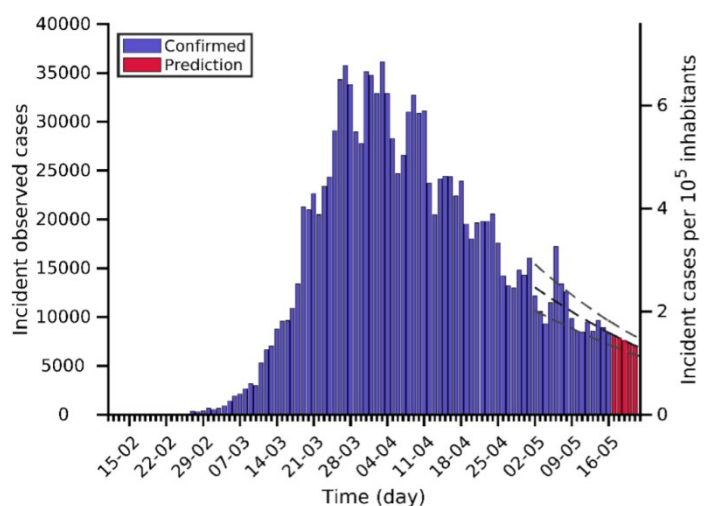
Attack rate and short-term predictions in EU+EFTA+UK

Short-term predictions, based on last 15 points with increased weight on last 3:



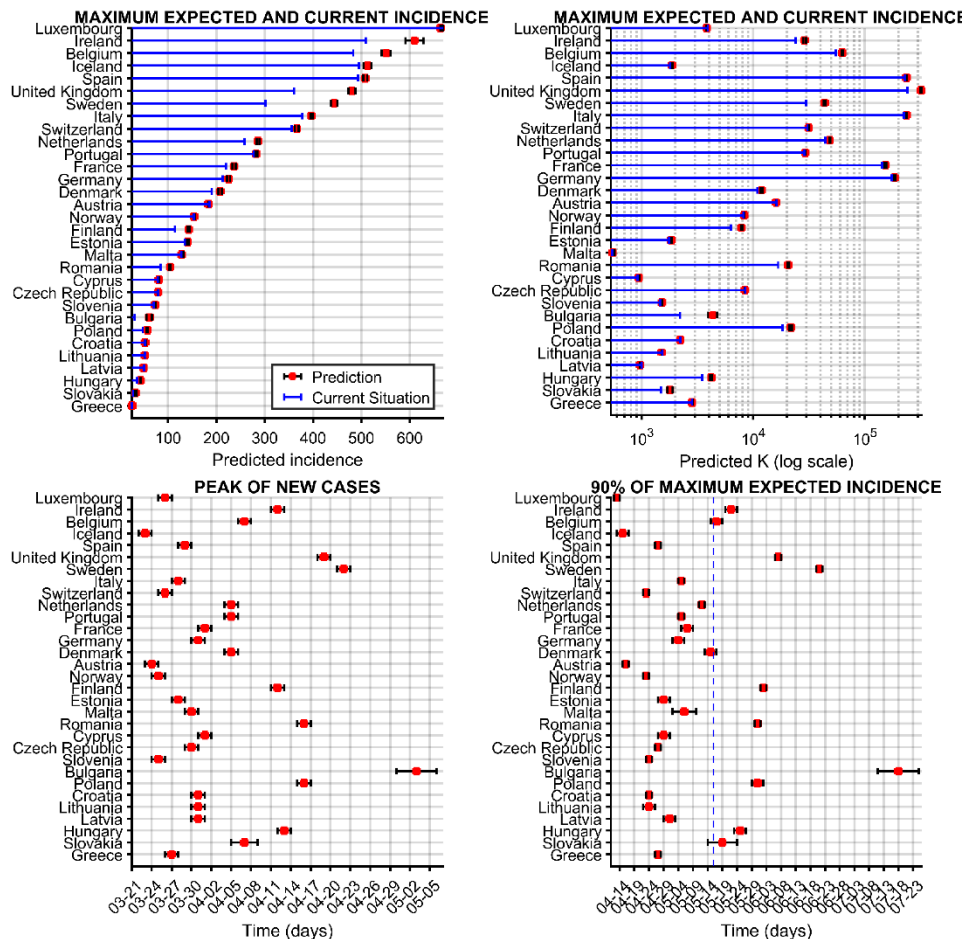
Highlights and/or warnings

- UE+EFTA+UK new cases are shown in the figure. They are currently at the level of 8,000-9,000.
- Today number of new cases (8,300) is the smallest value since 14-03-2020.
- Sweden and United Kingdom are the countries at highest risk ($EPG_{REP} \geq 70$).
- All countries maintain trends from previous days.
- There are several countries at $p_7 \geq 1$ but with low A_{14} (see table). These cases are not worrying if a significant increase is not observed in the next days.

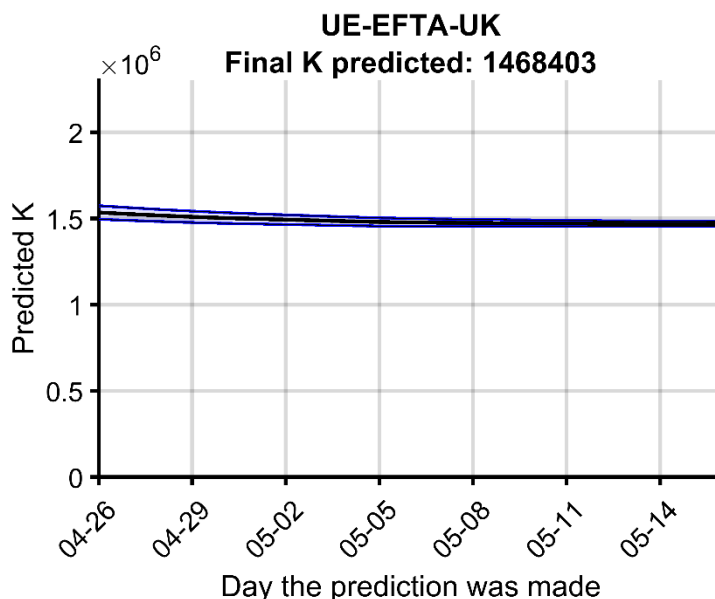


Long-term predictions

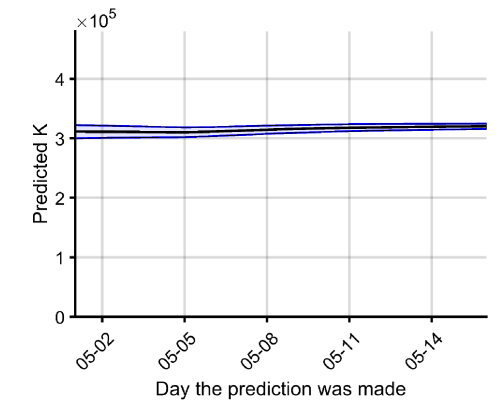
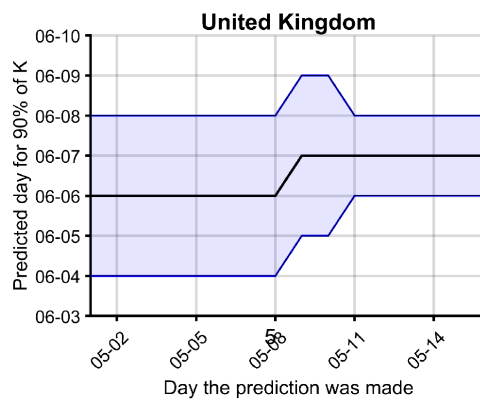
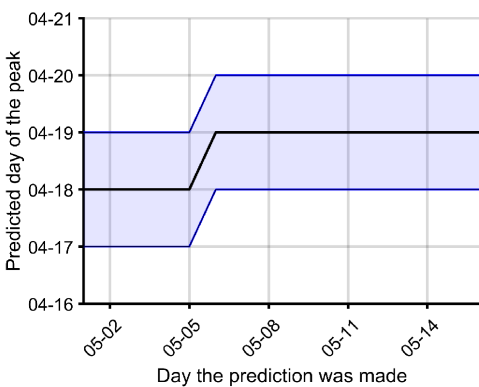
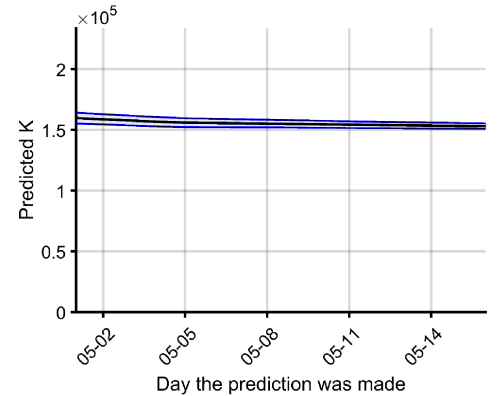
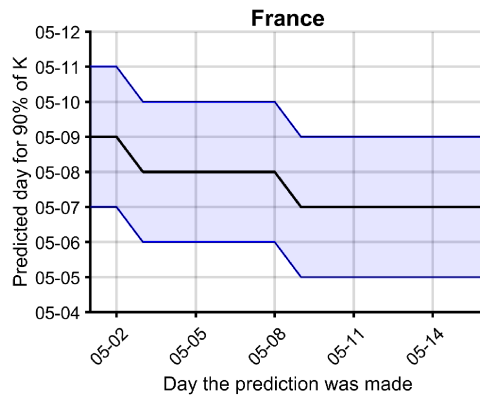
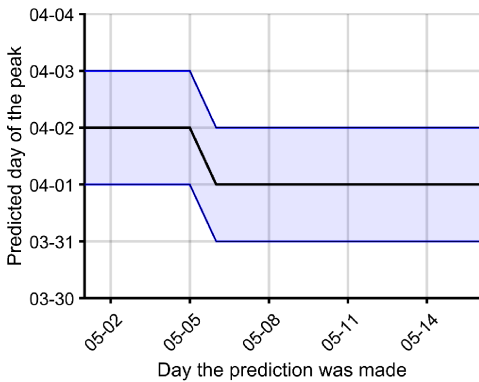
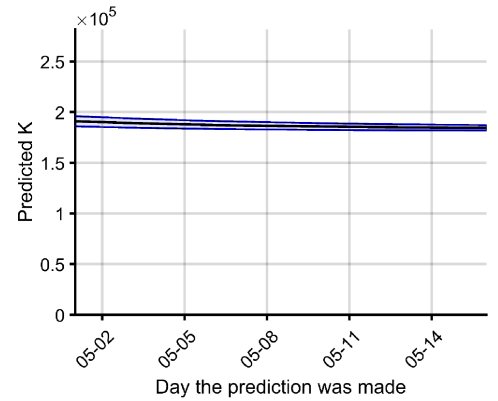
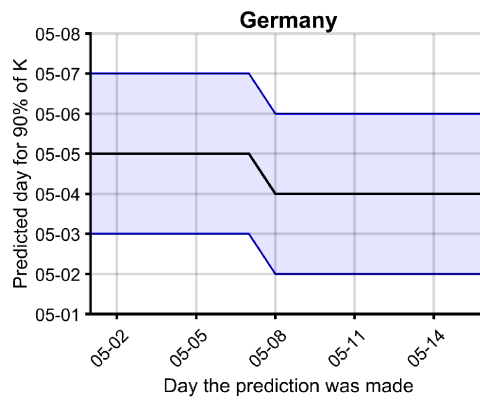
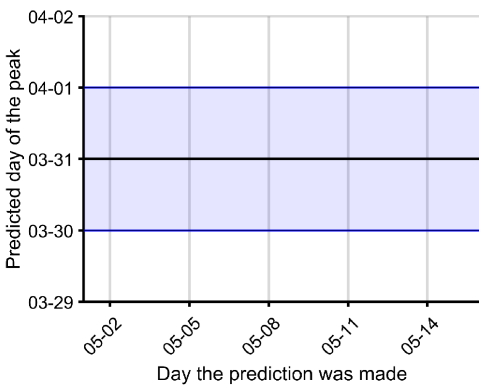
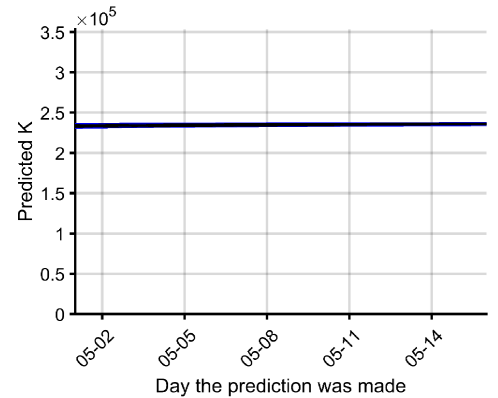
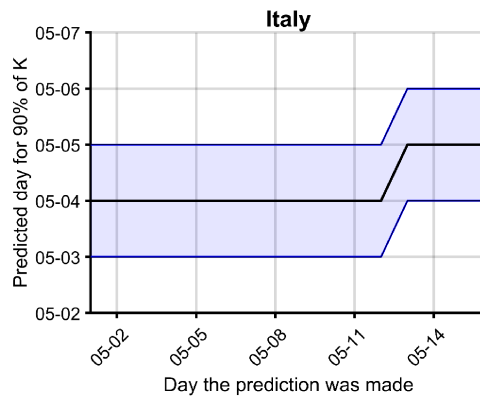
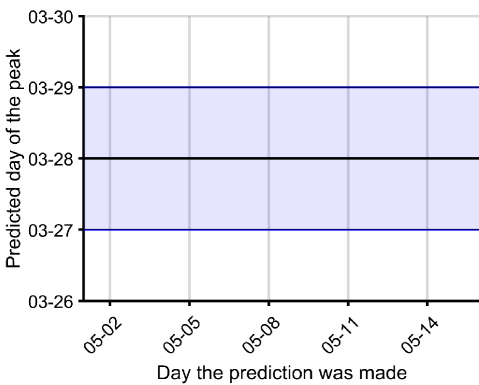
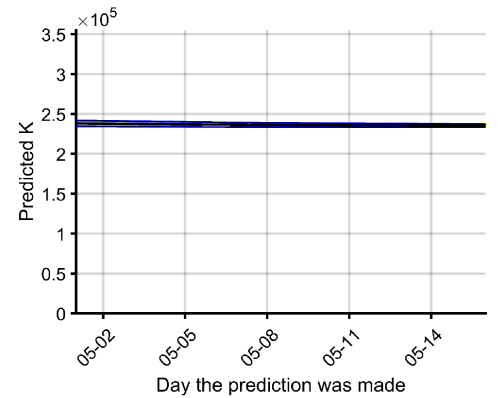
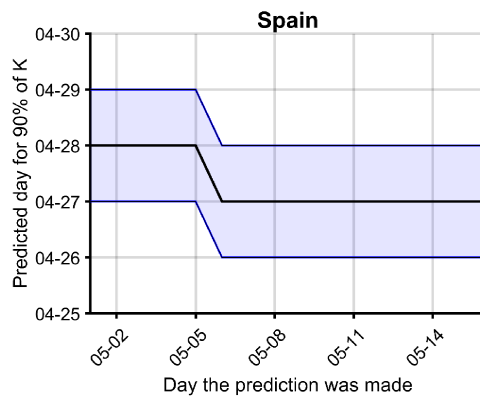
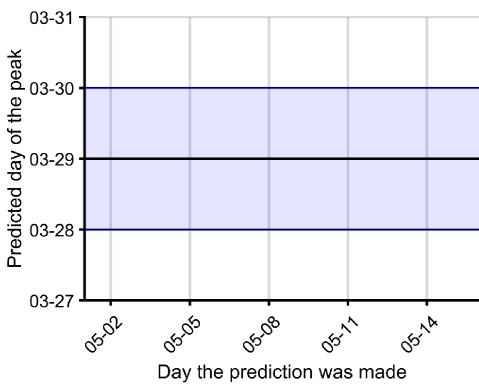
Long-term predictions, evaluated with the **whole historical series**. See figure in the next page. Up-left: Predictions of maximum incidences per country (total final expected attack rate per 10^5 inh.). Up-right: Predictions of maximum absolute number of cases per country (K, in log scale). Blue lines indicate current situation. Bottom-left: Time in which peak in new cases was achieved / will be achieved. Bottom-right: Time at which 90 % of K was achieved / will be achieved. Blue dotted line indicates current date.



Final expected K for UE+EFTA+UK. Evolution of predicted K with time, where convergence to best estimate is seen. Last prediction is numerically shown.



2020-05-16



Situation and trends per country

Maps. The map in the left shows current A_{14} . The map in the right shows current EPG .

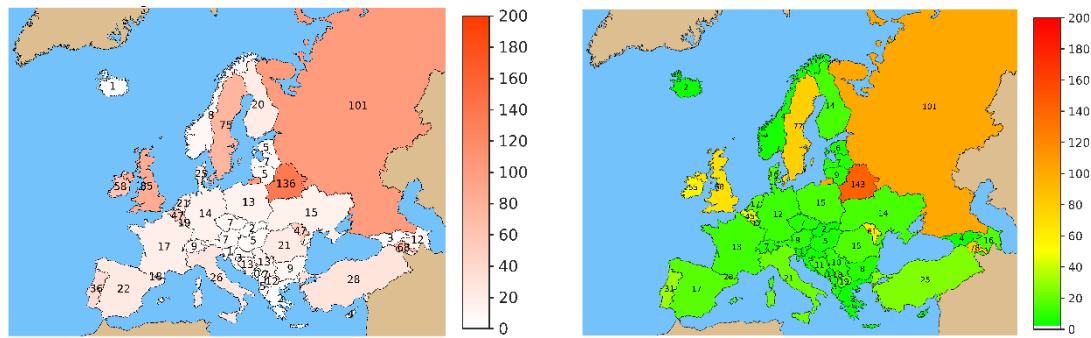


Table of current situation in EU countries. Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) from worst (red) situations according to each of the variables. EPG_{REP} and EPG_{EST} **cannot be compared between them** because scales are different, but can be independently used for estimating risk of countries according to reported or estimated real situation, respectively.

Country	Reported data						Indexes		
	Cumulative cases	Attack rate /10 ⁵ inh.	Cumulative deaths	Mortality /10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate /10 ⁵ inh.	$\rho_7^{(1)}$	$EPG_{REP}^{(2)}$	$EPG_{EST}^{(3)}$
United Kingdom	240,161	361.5	34,466	51.9	57,901	87.1	0.79	69	1,036
Spain	231,350	499.2	27,563	59.5	10,466	22.6	0.77	17	214
Italy	224,760	378.2	31,763	53.4	15,432	26.0	0.82	21	306
Germany	174,355	212.8	7,914	9.7	11,859	14.5	0.85	12	59
France	142,291	219.9	27,625	42.7	11,312	17.5	0.74	13	259
Belgium	54,989	484.1	9,005	79.3	5,472	48.2	0.95	46	765
Netherlands	43,870	258.3	5,670	33.4	3,634	21.4	0.79	17	224
Switzerland	30,489	355.8	1,601	18.7	755	8.8	0.83	7	39
Sweden	29,677	301.7	3,674	37.3	7,595	77.2	1.03	80	1,116
Portugal	28,810	277.8	1,203	11.6	3,620	34.9	0.86	30	130
Ireland	24,048	508.8	1,533	32.4	2,872	60.8	0.95	57	374
Poland	18,257	47.8	915	2.4	4,882	12.8	1.14	15	87
Romania	16,704	84.5	1,081	5.5	3,972	20.1	0.75	15	107
Austria	16,140	185.3	628	7.2	670	7.7	1.20	9	35
Denmark	10,858	190.1	543	9.5	1,451	25.4	0.65	17	83
Czech Republic	8,455	79.7	296	2.8	700	6.6	1.13	7	28
Norway	8,197	152.7	232	4.3	438	8.2	0.55	4	13
Finland	6,286	114.2	297	5.4	1,107	20.1	0.70	14	74
Luxembourg	3,930	682.3	104	18.1	118	20.5	0.91	19	46
Hungary	3,509	36.0	451	4.6	511	5.2	0.98	5	74
Greece	2,819	25.2	162	1.4	199	1.8	1.24	2	15
Croatia	2,224	52.8	95	2.3	136	3.2	0.99	3	NA
Bulgaria	2,211	31.0	108	1.5	617	8.7	0.86	7	42
Iceland	1,802	494.7	10	2.7	4	1.1	0.29	0	NA
Estonia	1,770	134.9	63	4.8	71	5.4	1.08	6	NA
Lithuania	1,534	52.8	55	1.9	128	4.4	1.96	9	NA
Slovakia	1,493	27.4	28	0.5	86	1.6	1.09	2	NA
Slovenia	1,465	70.5	103	5.0	26	1.3	0.82	1	8
Latvia	997	50.6	19	1.0	126	6.4	1.10	7	NA
Cyprus	914	78.1	17	1.5	50	4.3	0.74	3	NA
Malta	546	127.3	6	1.4	79	18.4	NA	NA	NA
Liechtenstein	83	215.3	1	2.6	0	0.0	NA	NA	NA

Scale									
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2.0	200	2000
Best	Best	Best	Best	Best	Best	Best	0.0	0	0

⁽¹⁾ ρ_7 is the average of 7 consecutive ρ , but can still fluctuate. ^(2,3) EPG stands for Effective Growth Potential. EPG_{REP} is obtained by multiplying attack rate of last 14 days per 10⁵ inhabitants (i.e. density of cases) by ρ_7 (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG_{EST} is obtained by multiplying estimated real attack rate of last 14 days per 10⁵ inhabitants by ρ_7 .

Time indicators by country

This table summarizes a few time indicators for each country: time since 50 cases were reported, time interval between an attack rate of $1/10^5$ inhabitants and an attack rate of $10/10^5$ inhabitants, and time interval between attack rates of 10 to 100 per 10^5 inhabitants (only for countries that have overtaken this threshold).

Countries	Days since the first 100 cases	Time interval between 1 and 10 cases / 10^5 inh. (days)	Time interval between 10 and 100 cases / 10^5 inh. (days)
Italy	84	11	16
Germany	78	12	17
France	77	10	20
Spain	76	8	12
United Kingdom	73	10	12
Belgium	72	11	14
Netherlands	72	11	20
Sweden	72	10	28
Norway	72	2	7
Switzerland	72	8	11
Austria	70	10	14
Denmark	69	4	30
Czech Republic	66	11	NA
Finland	66	12	46
Greece	66	18	NA
Iceland	66	5	15
Portugal	65	9	15
Slovenia	65	6	NA
Estonia	64	5	30
Ireland	64	8	18
Poland	64	17	NA
Romania	64	15	NA
Luxembourg	61	6	7
Slovakia	60	24	NA
Bulgaria	59	30	NA
Croatia	59	12	NA
Hungary	58	20	NA
Latvia	58	12	NA

Situation, trends and long-term predictions in Italian and Spanish regions

Italy

Country	Reported data						Indexes		
	Cumulative cases	Attack rate / 10 ⁵ inh.	Cumulative deaths	Mortality / 10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate / 10 ⁵ inh.	$p_7^{(1)}$	EPG _{REP} ⁽²⁾	EPG _{EST} ⁽³⁾
Lombardia	84.844	844,9	15.519	154,5	7.316	72,9	0,84	61	1.140
Piemonte	29.547	678,2	3.612	82,9	2.117	48,6	0,82	40	506
Emilia Romagna	27.232	610,7	3.973	89,1	1.216	27,3	0,67	18	271
Veneto	18.941	386,1	1.794	36,6	623	12,7	0,68	9	87
Toscana	9.948	266,7	984	26,4	385	10,3	0,94	10	99
Liguria	9.159	590,7	1.355	87,4	800	51,6	0,99	51	780
Lazio	7.446	126,7	622	10,6	637	10,8	0,96	10	92
Marche	6.667	437,1	984	64,5	348	22,8	0,76	17	255
Campania	4.684	80,7	396	6,8	200	3,4	0,92	3	28
Puglia	4.379	108,7	470	11,7	235	5,8	0,55	3	35
Trento	4.338	404,6	453	42,2	91	8,5	1,07	9	231
Sicilia	3.388	67,8	267	5,3	148	3,0	0,82	2	20
Friuli Venezia Giulia	3.191	262,6	319	26,3	119	9,8	1,00	10	103
Abruzzo	3.186	242,9	385	29,4	190	14,5	0,96	14	178
Bolzano	2.581	2.402,4	290	269,9	45	41,9	0,61	25	58
Umbria	1.424	161,4	73	8,3	30	3,4	1,00	3	NA
Sardegna	1.353	82,5	125	7,6	34	2,1	1,08	2	22
Valle d'Aosta	1.173	933,9	143	113,8	31	24,7	1,28	32	409
Calabria	1.151	59,1	95	4,9	37	1,9	1,12	2	NA
Molise	411	134,5	22	7,2	110	36,0	1,48	53	NA
Basilicata	392	69,6	27	4,8	6	1,1	0,00	0	NA

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	200
Best	Best	Best	Best	Best	Best	Best	0,0	0

Spain

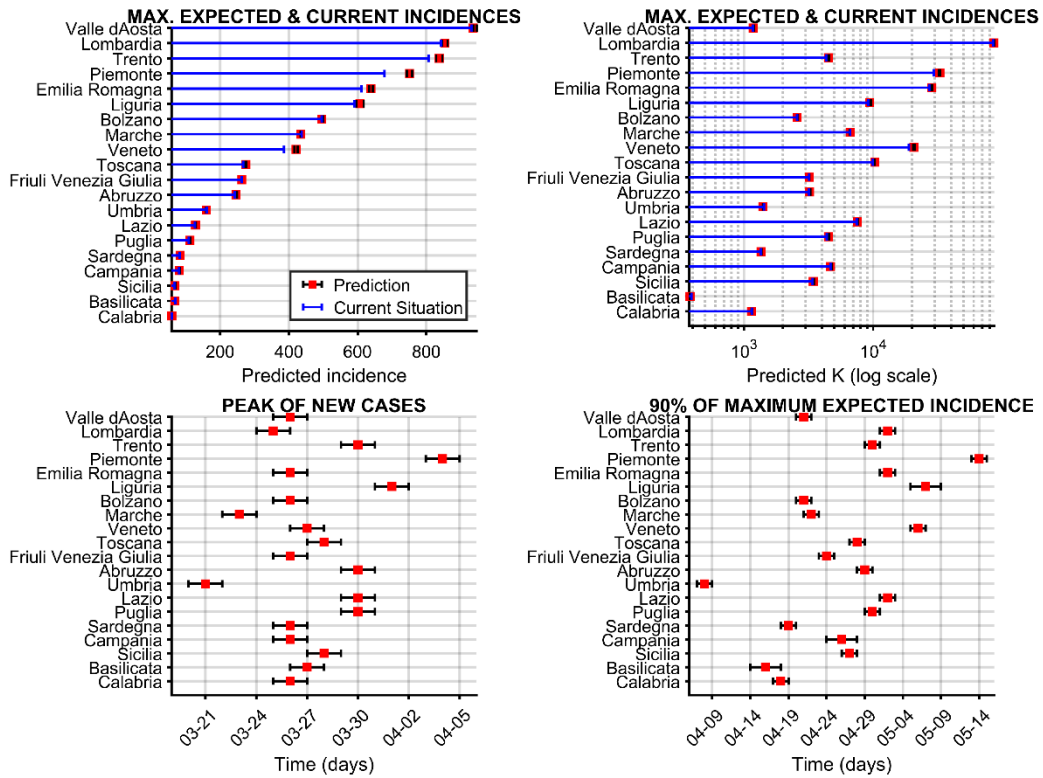
Autonomous regions	Reported data						Indexes		
	Cumulative cases	Attack rate / 10 ⁵ inh.	Cumulative deaths	Mortality rate / 10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate / 10 ⁵ inh.	$p_7^{(1)}$	EPG _{REP} ⁽²⁾	EPG _{EST} ⁽³⁾
Madrid	66.338	999,0	8.847	133,2	2.544	38,3	0,81	31	416
Catalunya	53.150	702,6	5.944	78,6	2.916	38,5	0,64	25	283
Castilla y Leon	18.470	767,0	1.946	80,8	1.187	49,3	0,89	44	483
Castilla-La Mancha	16.618	816,4	2.893	142,1	601	29,5	0,86	25	454
Euskadi	13.407	615,6	1.459	67,0	469	21,5	1,27	27	310
Andalucia	12.450	147,7	1.358	16,1	311	3,7	1,46	5	61
Comunitat Valenciana	10.893	219,0	1.366	27,5	457	9,2	0,75	7	88
Galicia	9.340	345,9	606	22,4	373	13,8	0,41	6	39
Aragon	5.478	414,8	838	63,4	314	23,8	1,1	26	407
Navarra	5.148	792,0	503	77,4	246	37,8	0,71	27	270
La Rioja	4.024	1.283,2	349	111,3	72	23,0	0,50	12	99
Extremadura	2.958	277,6	500	46,9	114	10,7	1,00	11	192
Asturias	2.366	231,4	315	30,8	54	5,3	0,76	4	53
Canarias	2.289	103,7	151	6,8	68	3,1	1,14	4	24
Cantabria	2.268	389,9	207	35,6	63	10,8	0,95	10	99
Baleares	1.991	167,6	218	18,4	85	7,2	1,2	9	103
Murcia	1.551	104,3	144	9,7	59	4,0	1,84	7	70
Melilla	121	142,8	2	2,4	4	4,7	NA	NA	NA
Ceuta	116	136,7	4	4,7	15	17,7	NA	NA	NA

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	200
Best	Best	Best	Best	Best	Best	Best	0,0	0

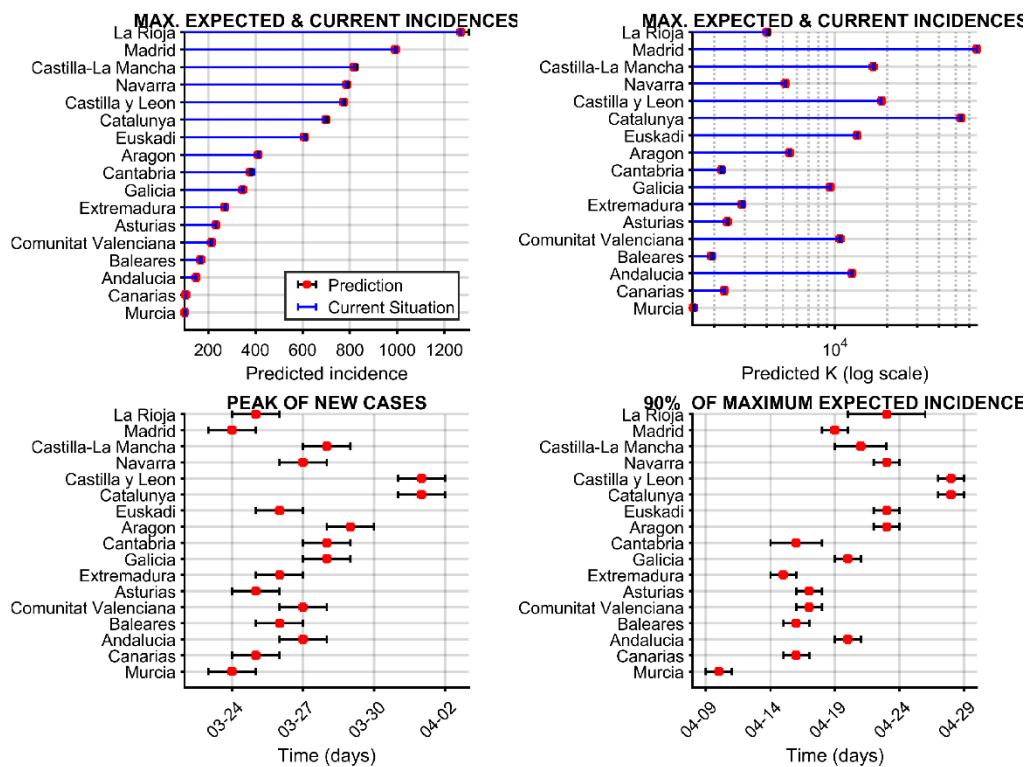
⁽¹⁾ Disclaimer: parameter p is very sensitive and experiments daily variations. P_7 is the average of 7 consecutive p , but can still fluctuate. ^(2,3) EPG stands for Effective Growth Potential. EPG_{REP} is obtained by multiplying attack rate of last 14 days per 10⁵ inhabitants (i.e. density of cases) by p_7 (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG_{EST} is obtained by multiplying estimated real attack rate of last 14 days per 10⁵ inhabitants by p_7 .

Long-term predictions. Next plots show long-term predictions of: new cases' peaks, final incidence value and approximate date when 90% of total final incidence will be reached. In all three cases we are dealing with the evaluation of global dynamics, which requires small changes in methodology: all data points be used instead of last 15 and with equal weight distribution among them. Blue dashed line indicates current timepoint. See details in Report from 11th April 2020.

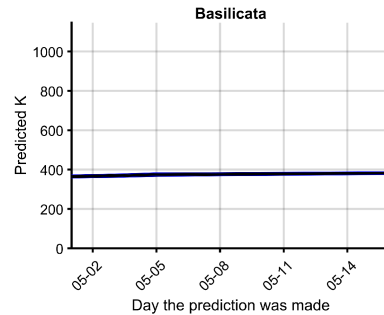
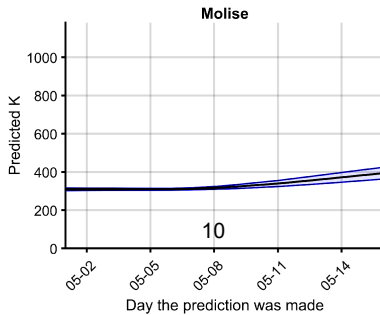
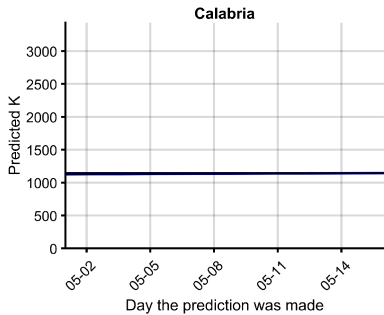
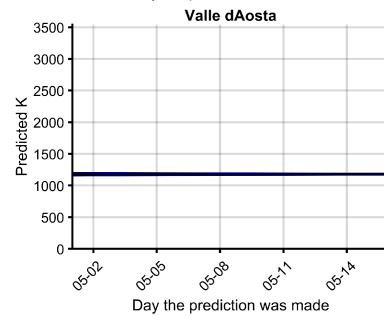
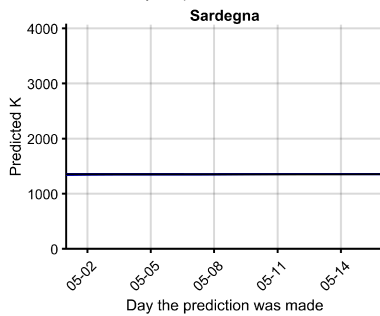
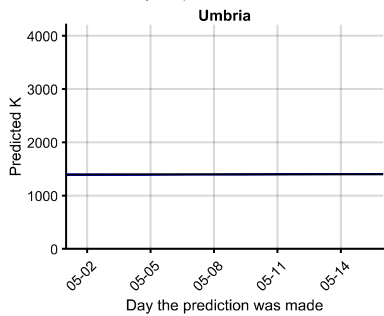
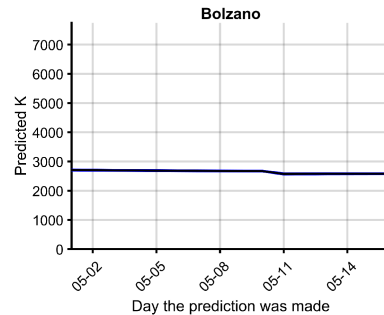
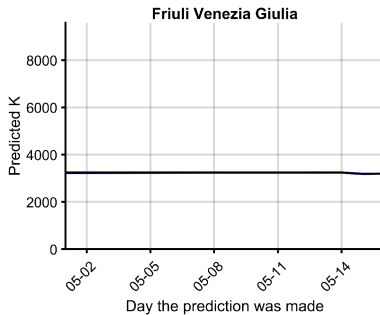
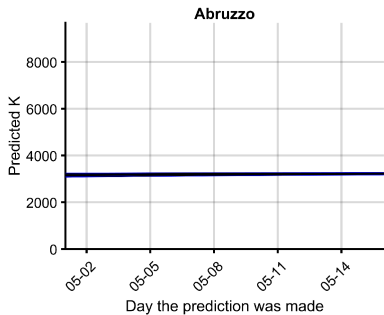
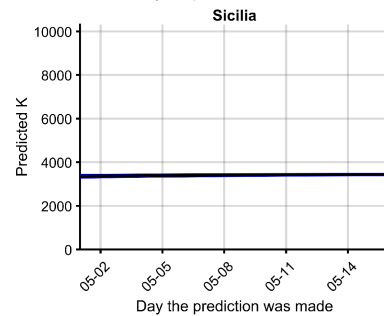
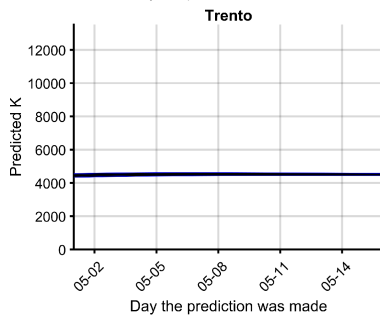
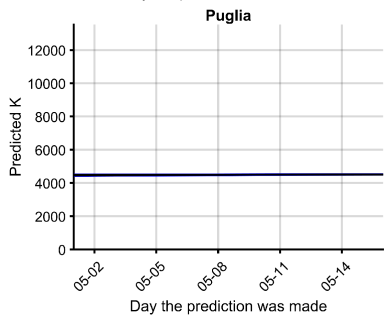
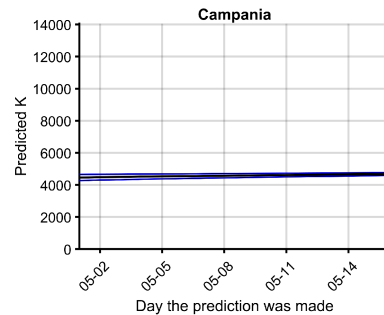
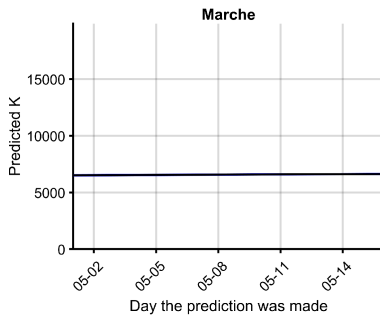
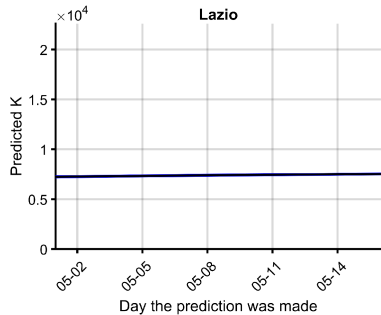
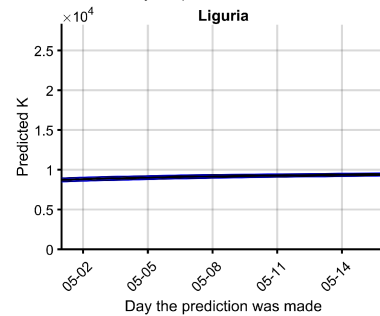
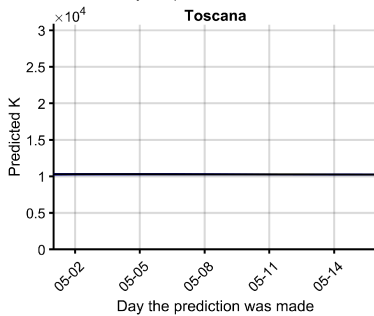
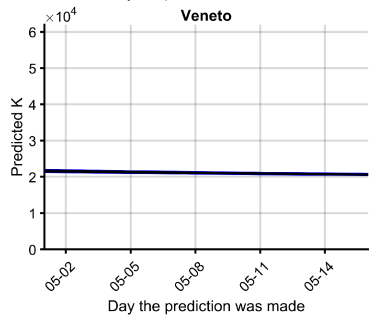
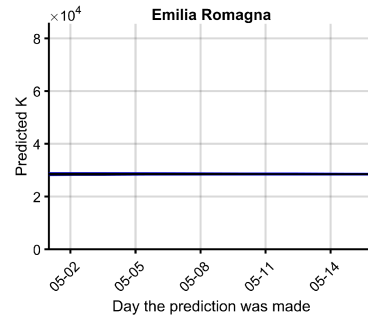
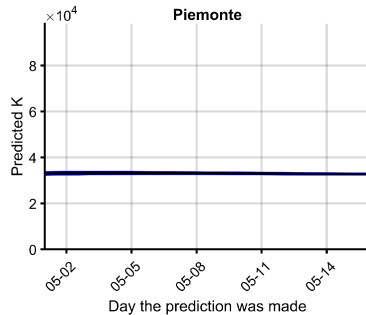
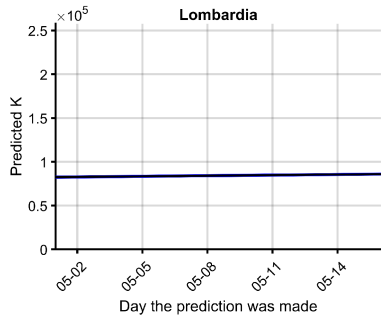
Italy



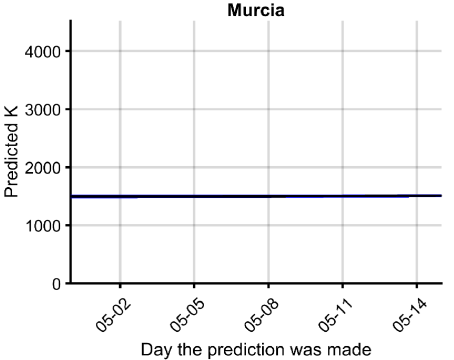
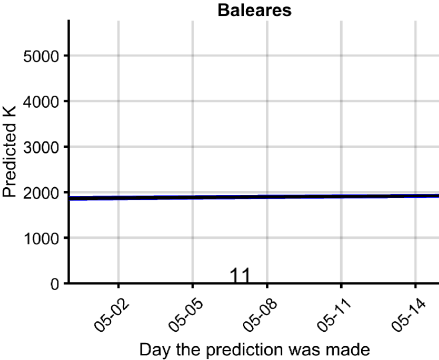
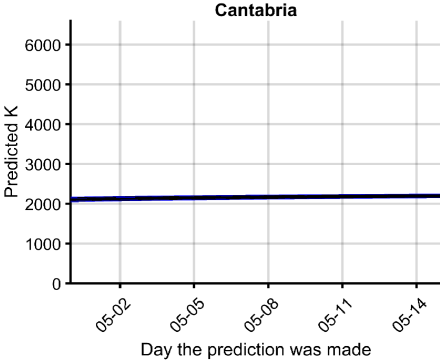
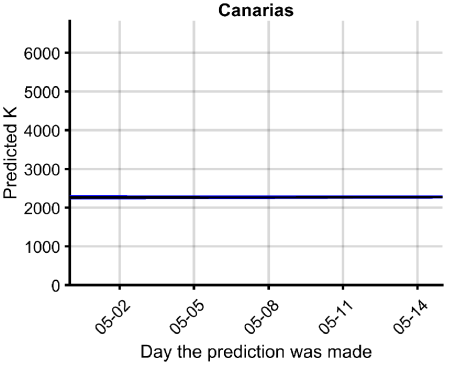
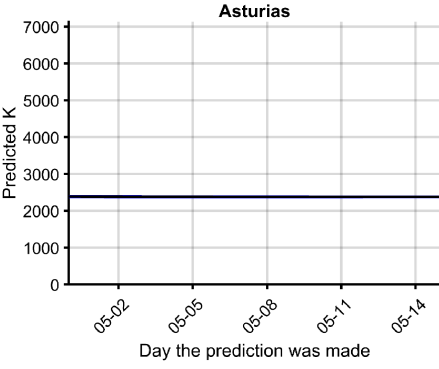
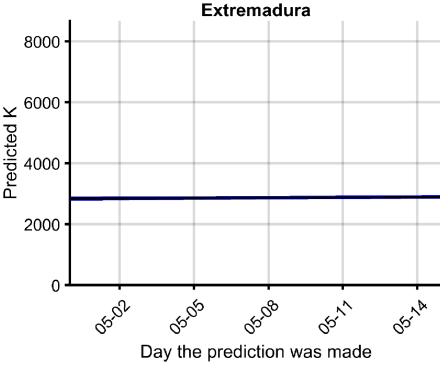
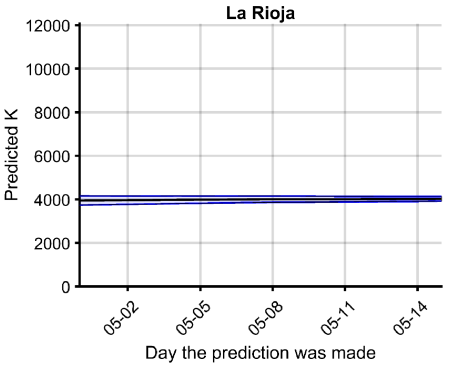
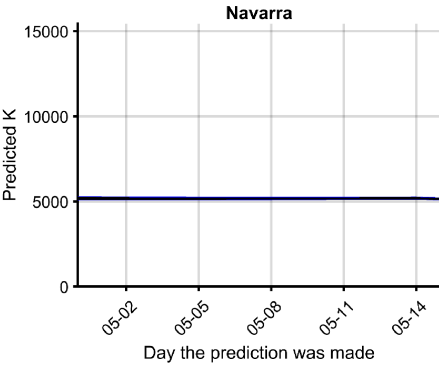
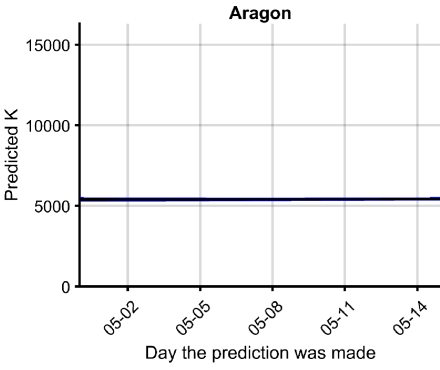
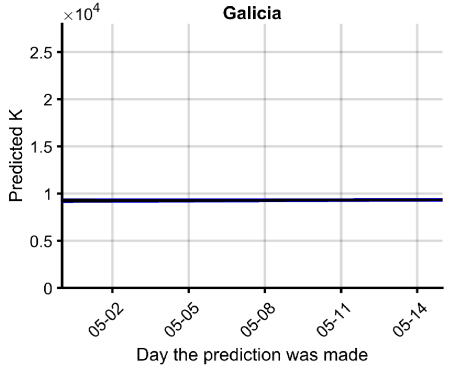
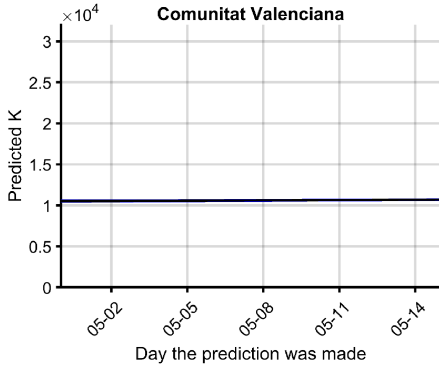
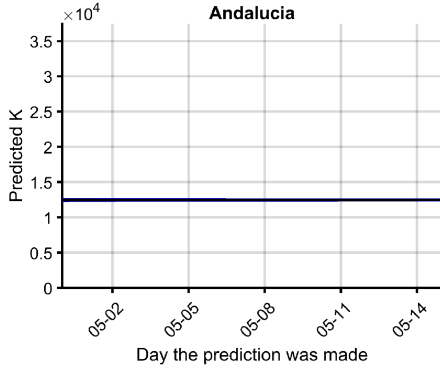
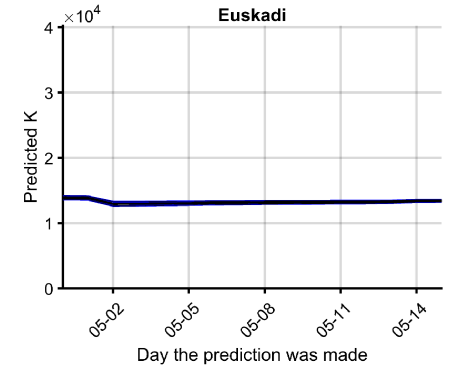
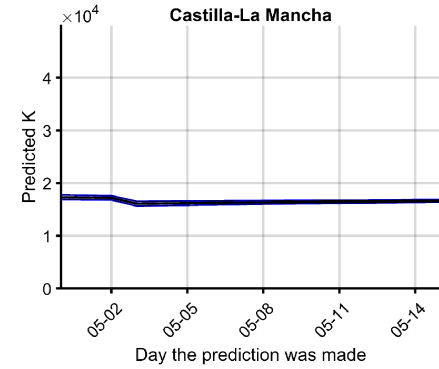
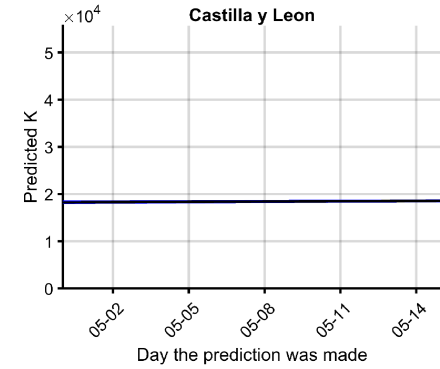
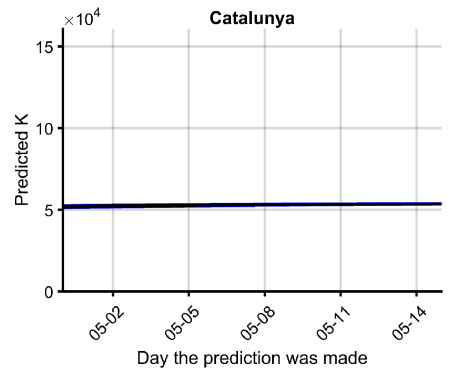
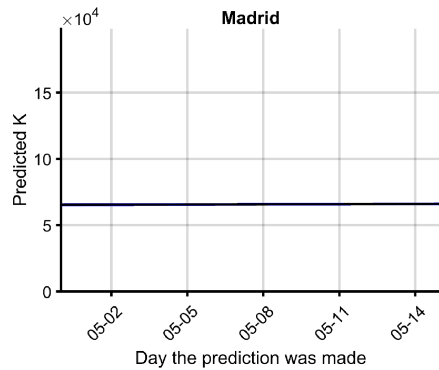
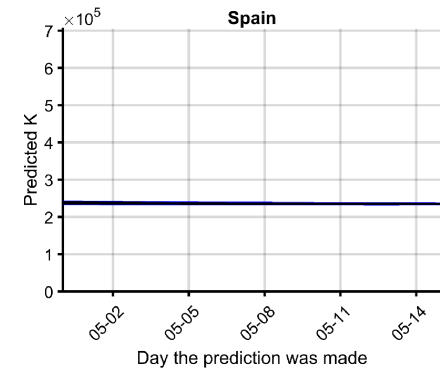
Spain



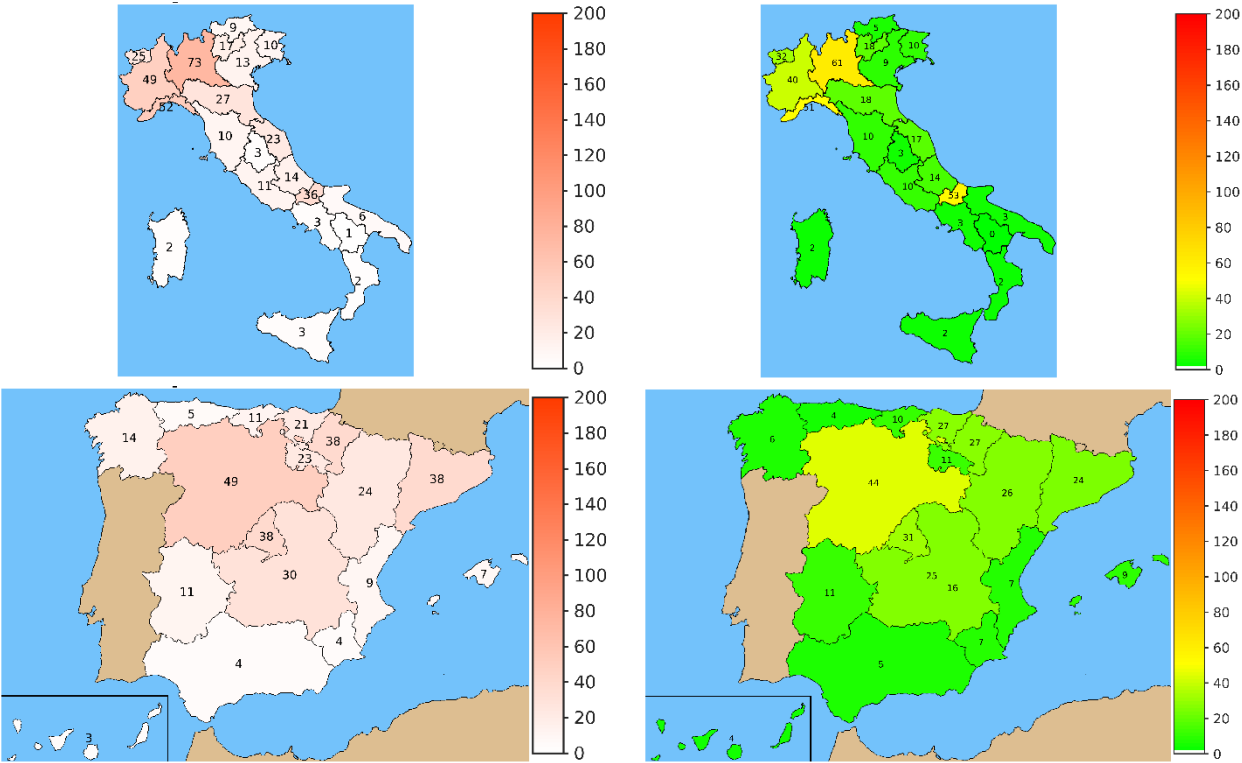
2020-05-17



2020-05-16



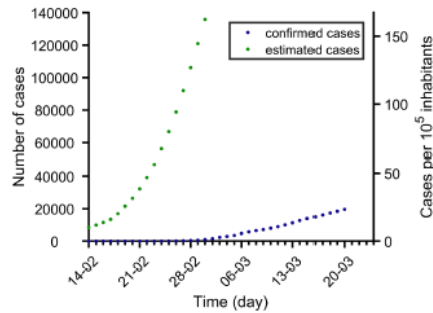
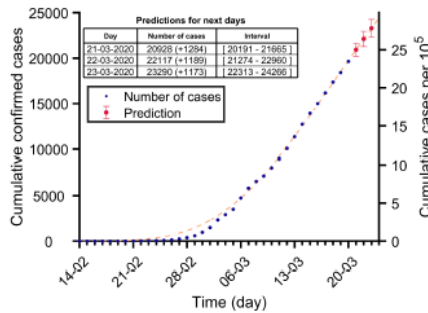
Maps. The maps in the left show current A_{14} . The maps in the right show current EPG .



Legend: Countries' reports details

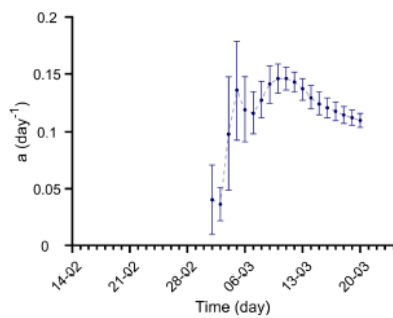
Iran 20-03-2020. Population: 83.7M. Current cumulated incidence: $23/10^5$

Confirmed cases:
data (blue),
model fitted
(dashed line),
predictions (red
points and table)

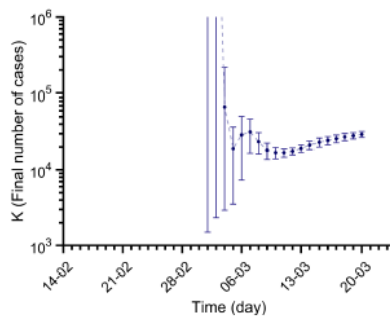


Estimated
cases using
death rate (see
Methods)

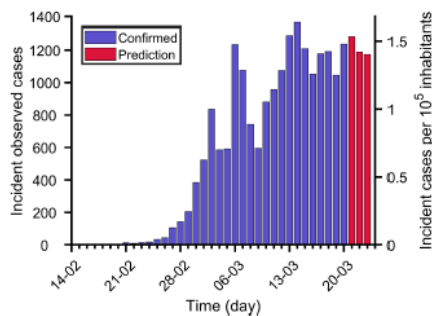
Fitted a value
using points
prior to each
date



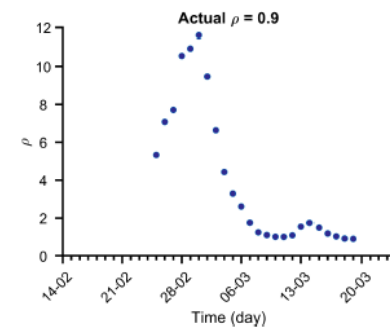
Fitted K value
using points
prior to each
date



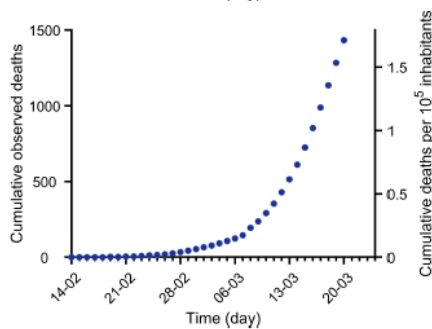
Reported
and
predicted
new cases



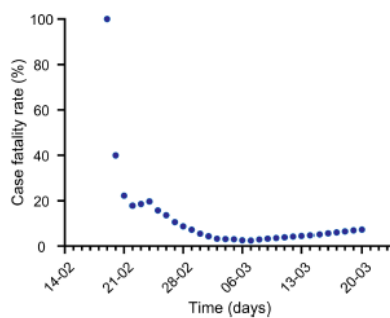
Evolution of ρ , a
parameter related
with Reproduction
number (see
Methods)



Reported
deaths

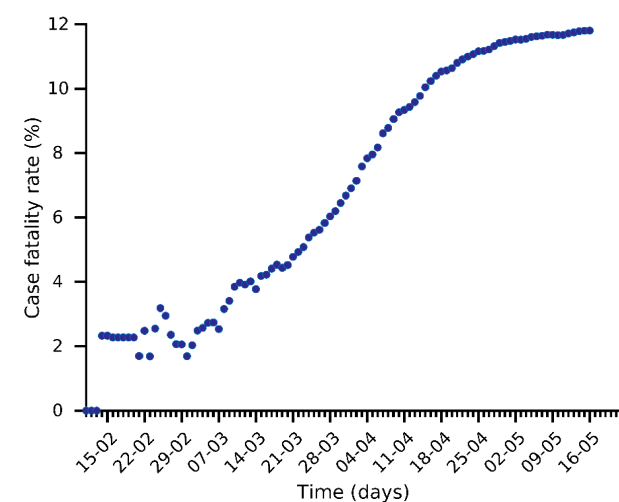
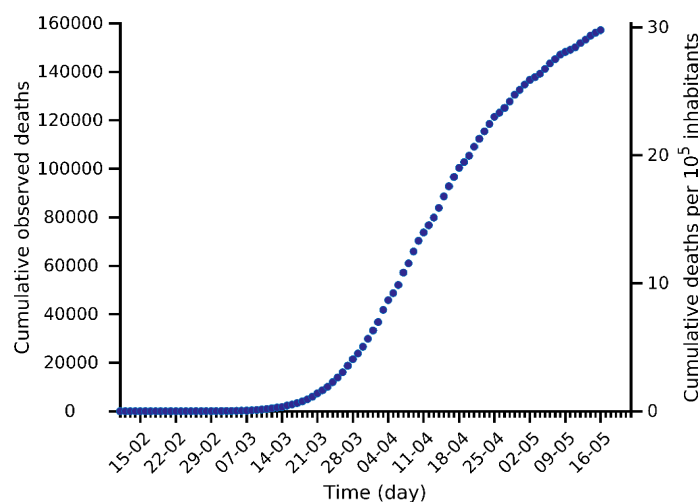
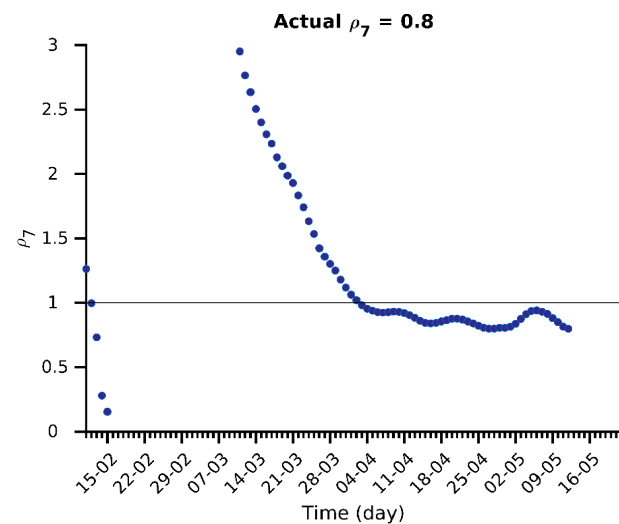
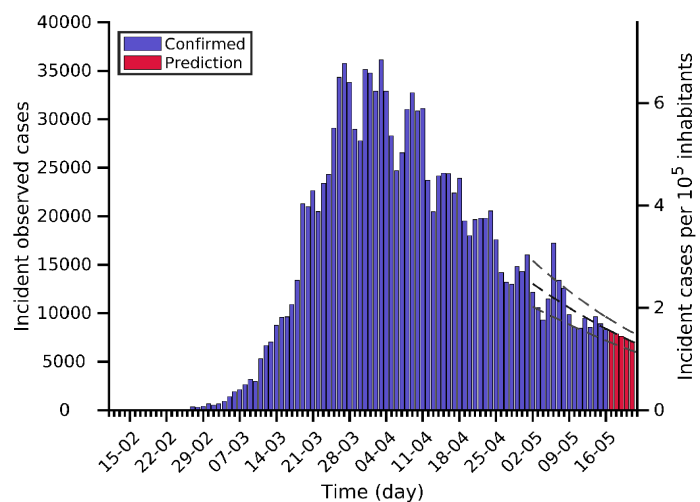
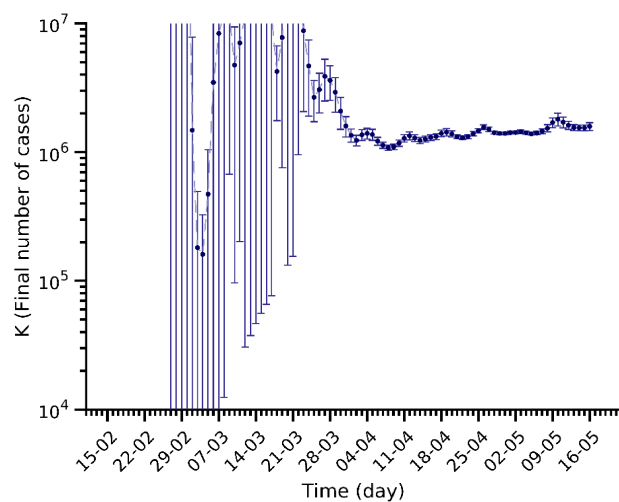
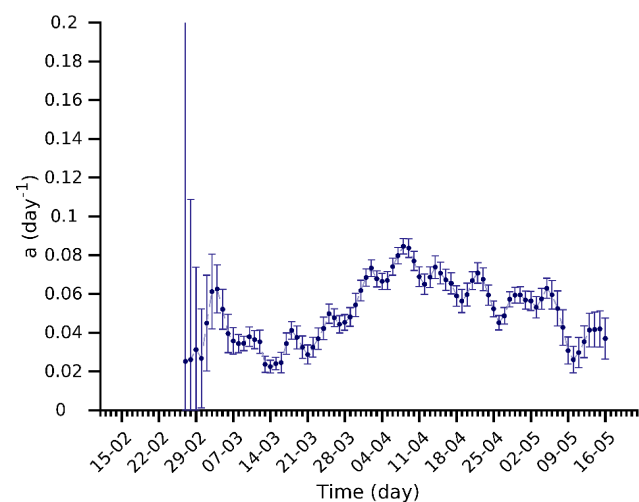
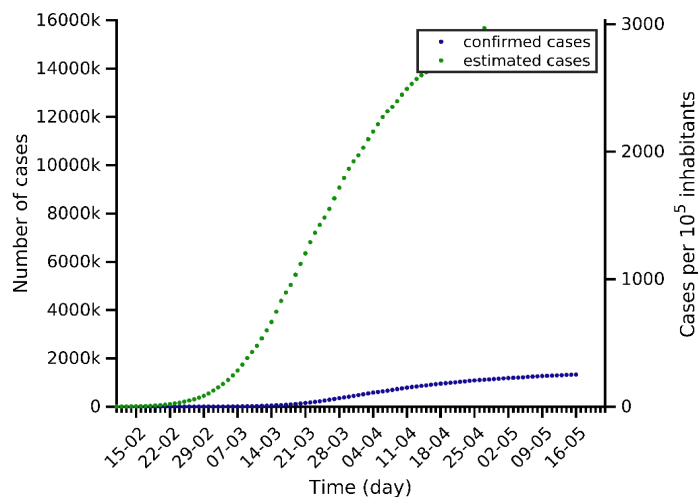
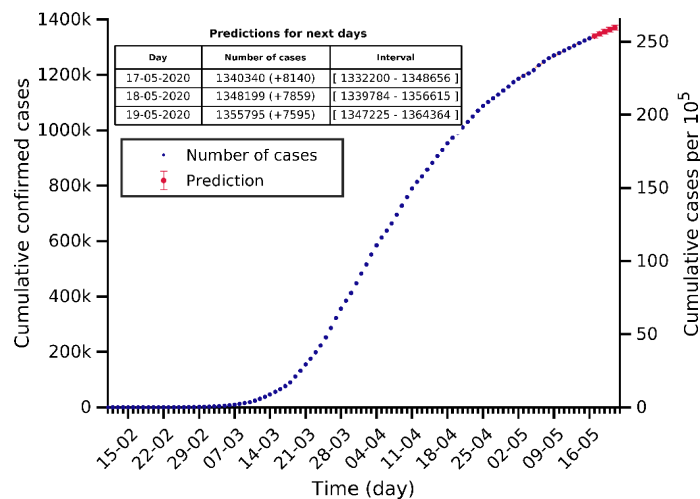


Deaths /
cumulated
reported cases

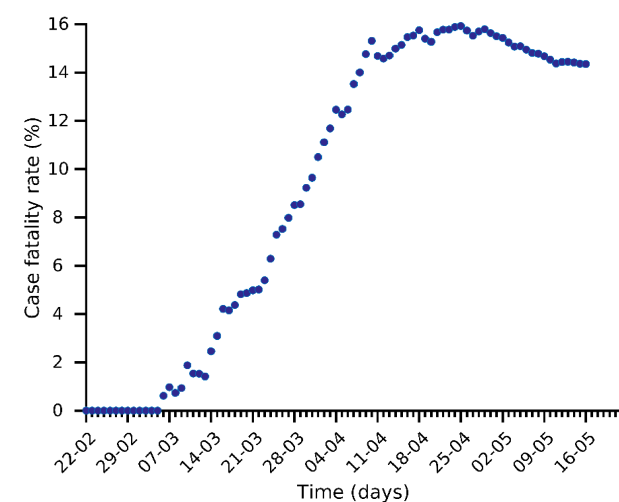
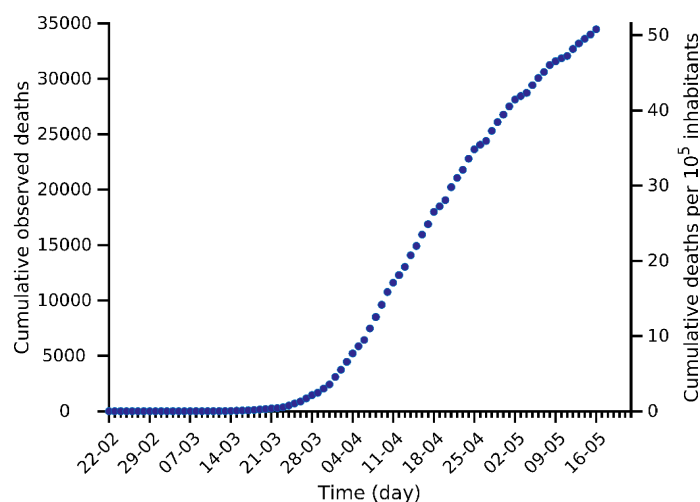
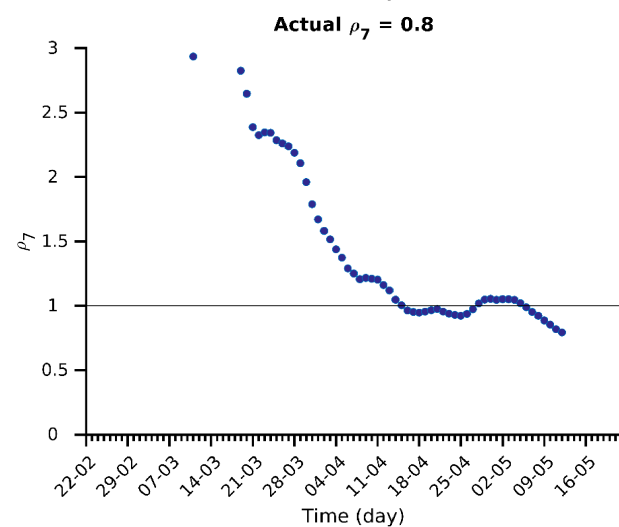
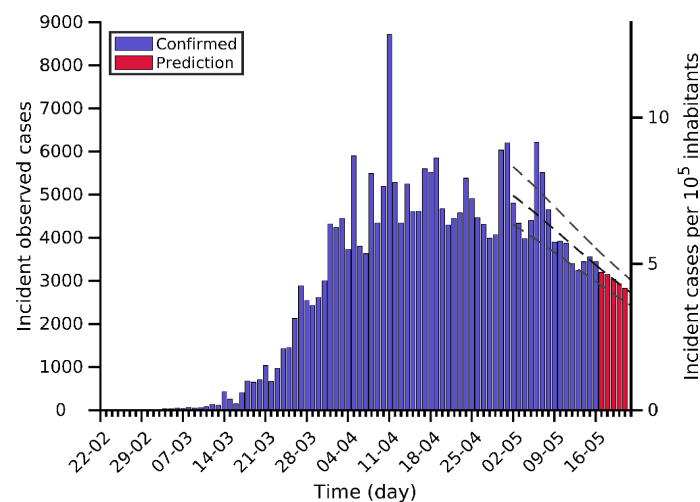
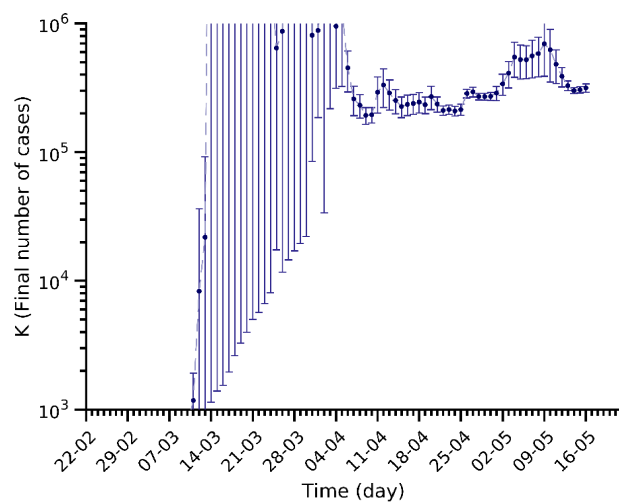
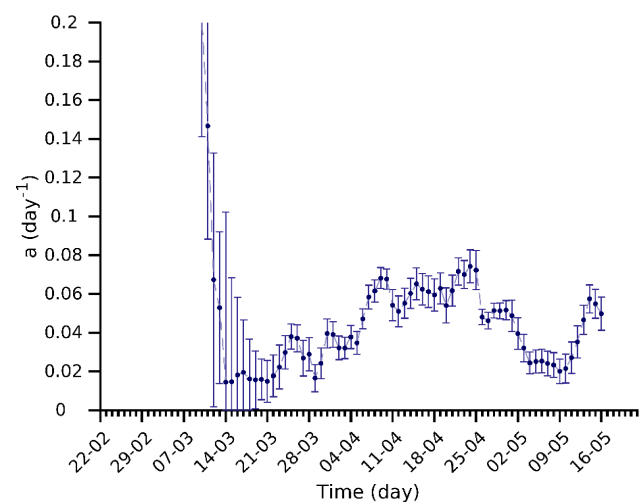
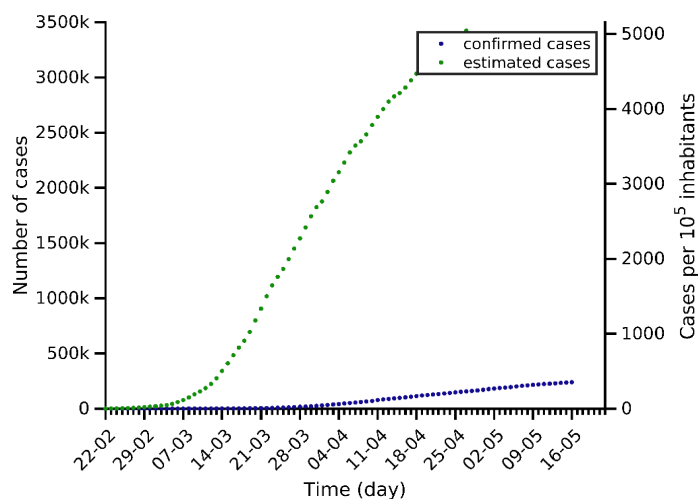
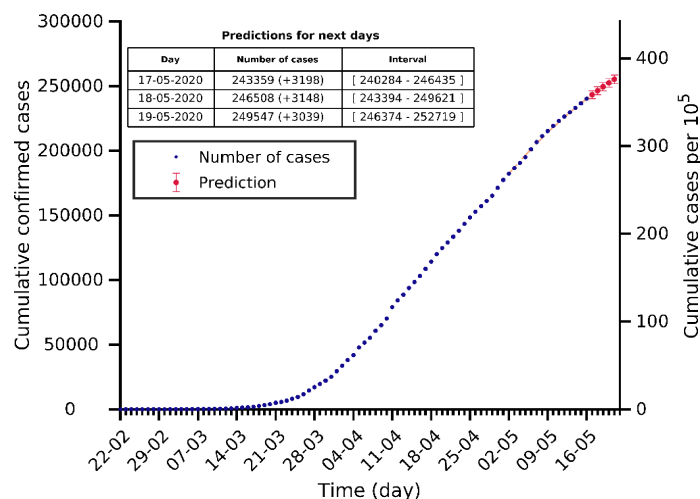


(1) Analysis and prediction of COVID-19 for EU+EFTA+UK

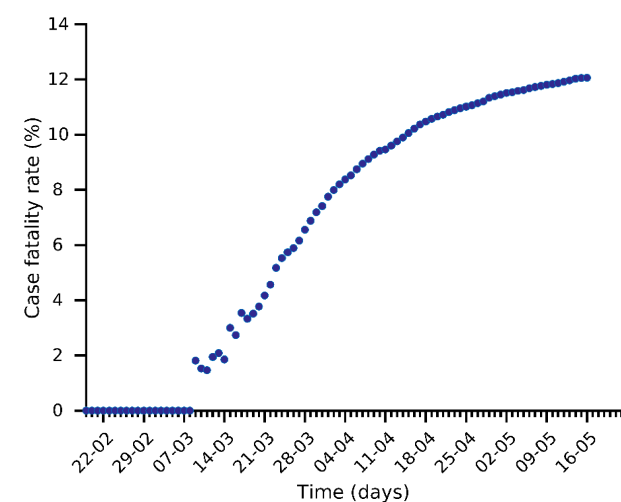
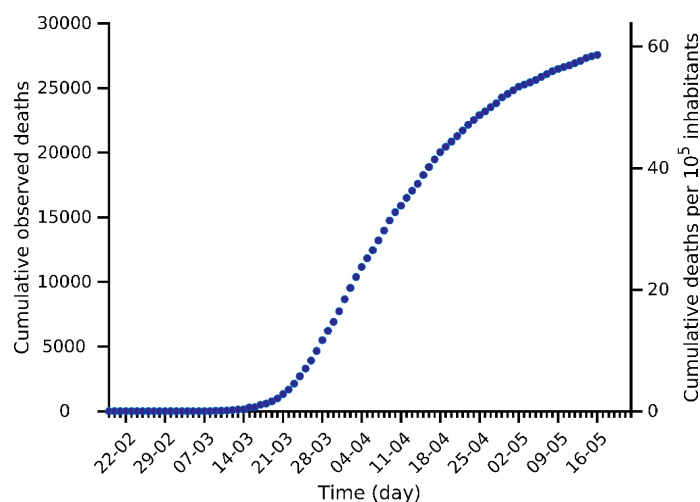
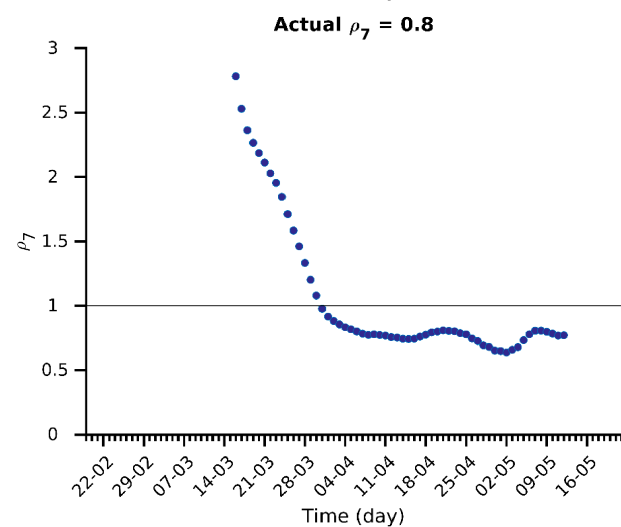
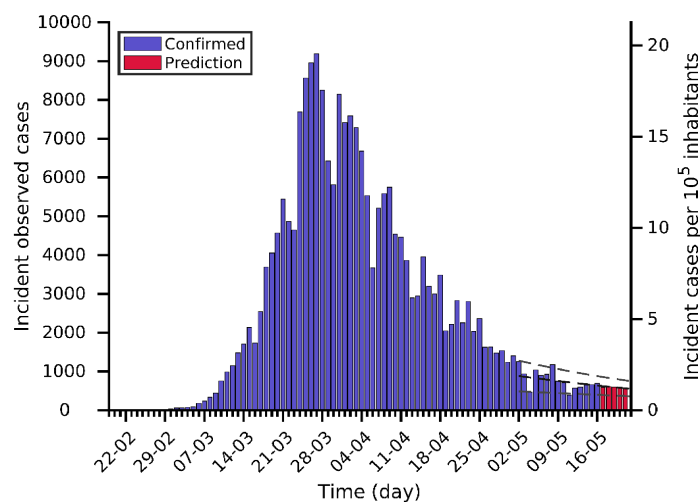
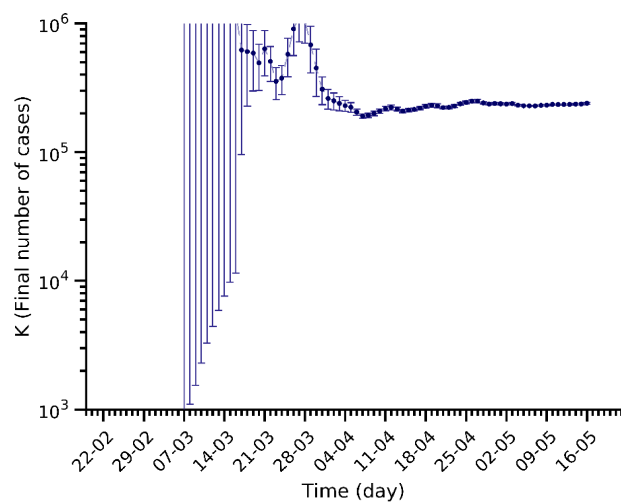
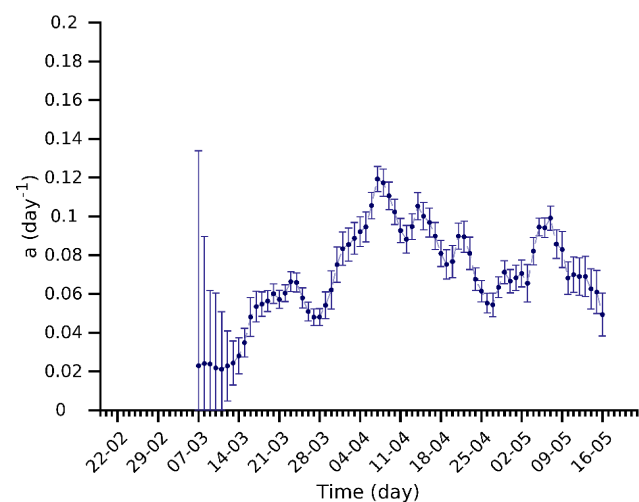
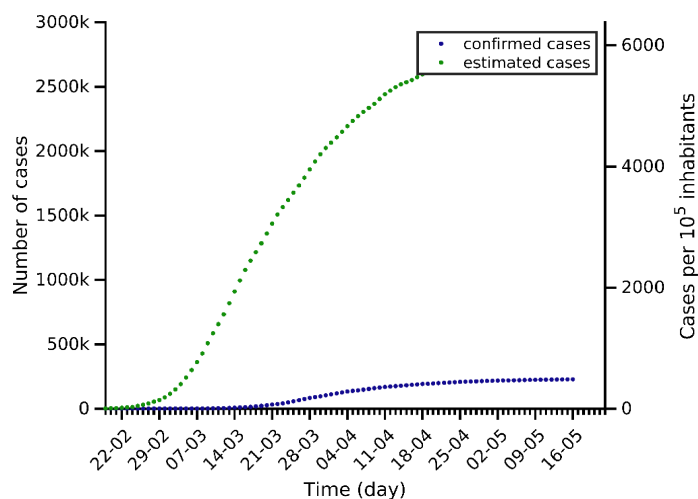
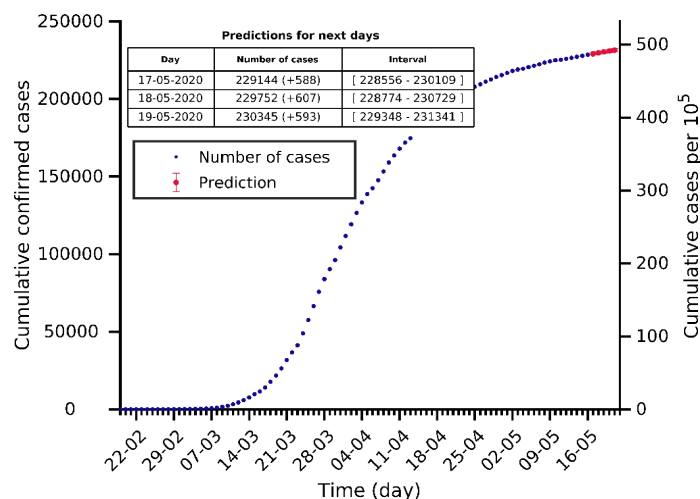
Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>



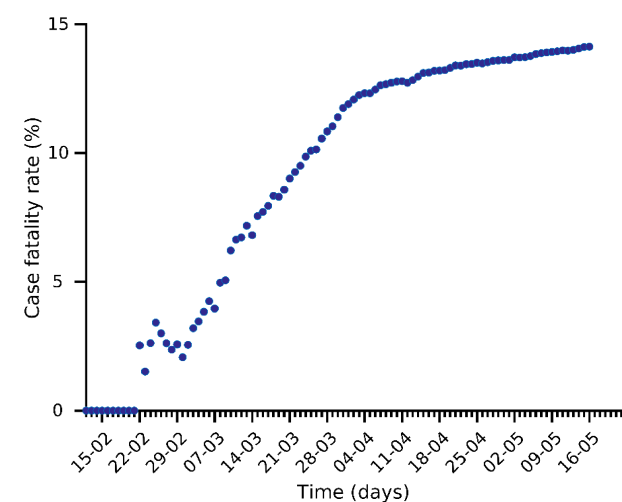
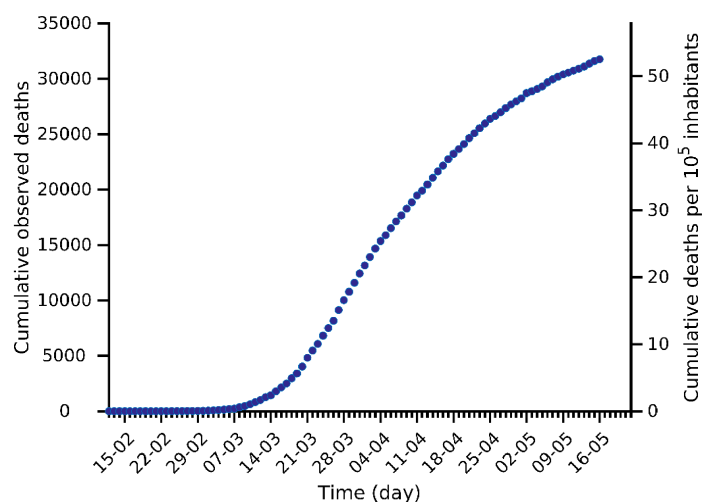
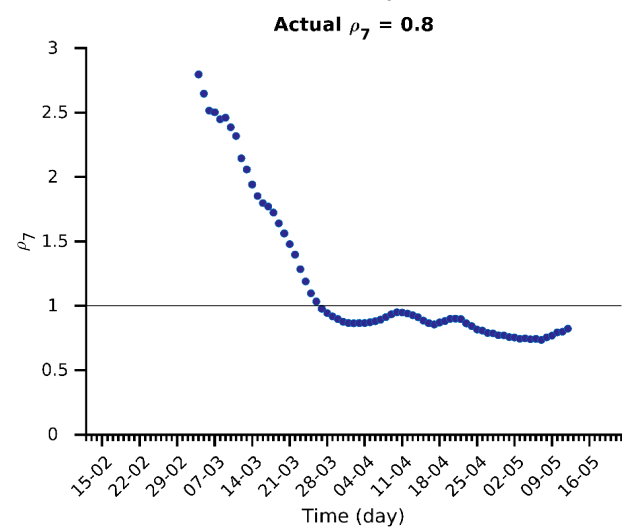
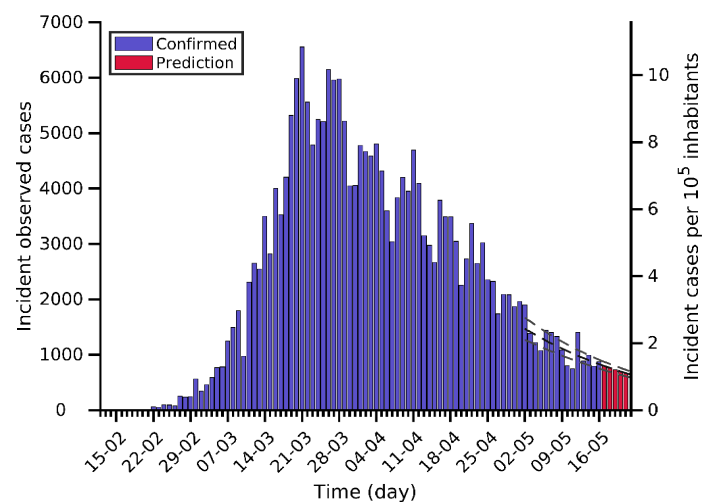
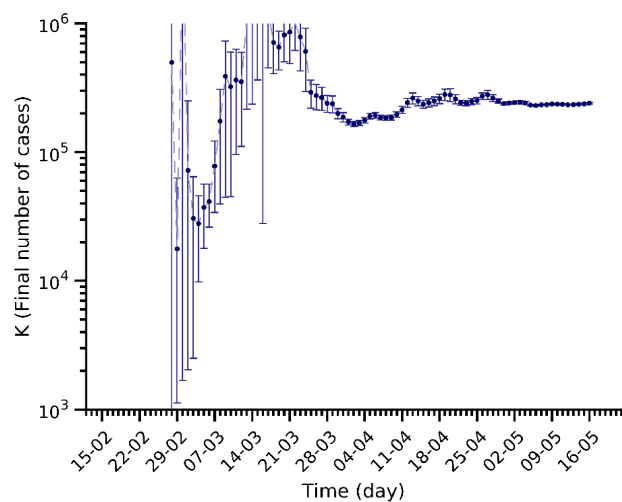
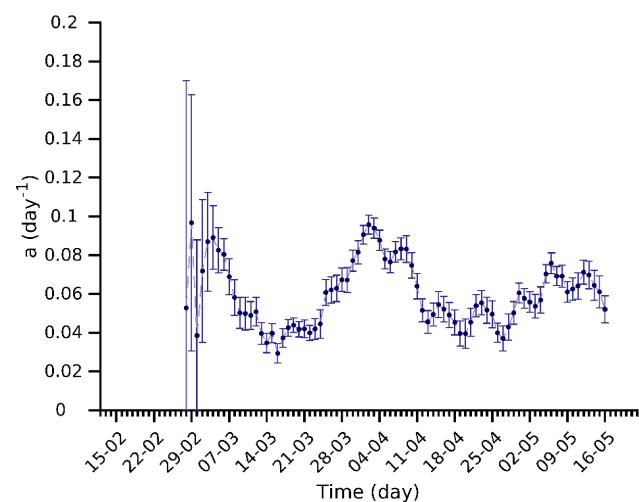
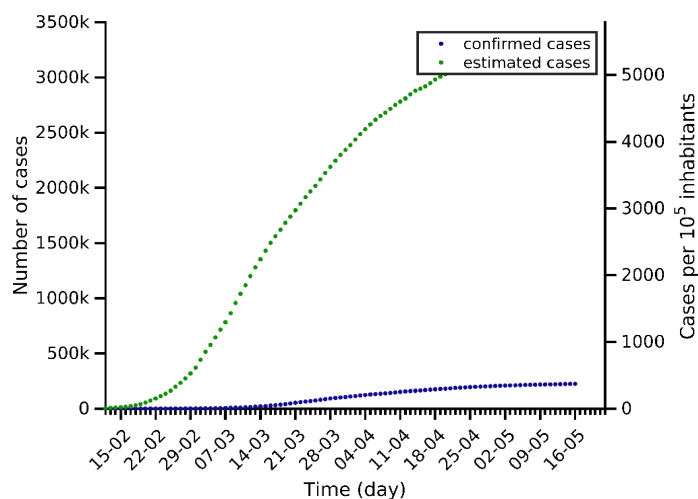
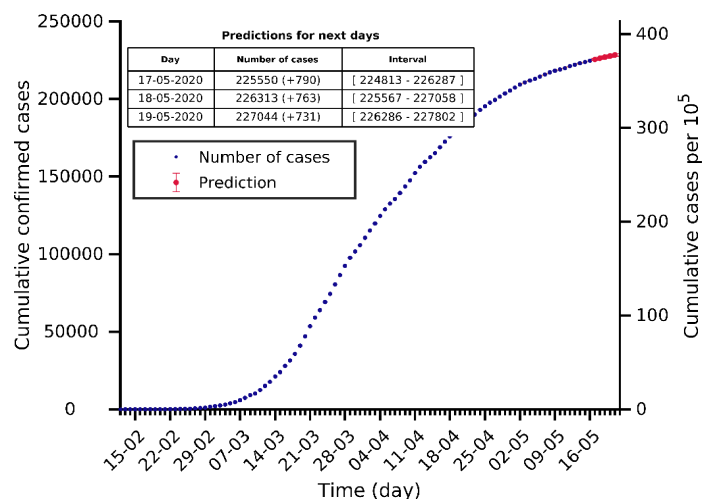
UK 16-05-2020. Population: 67.9M. Current cumulated incidence: 354/10⁵



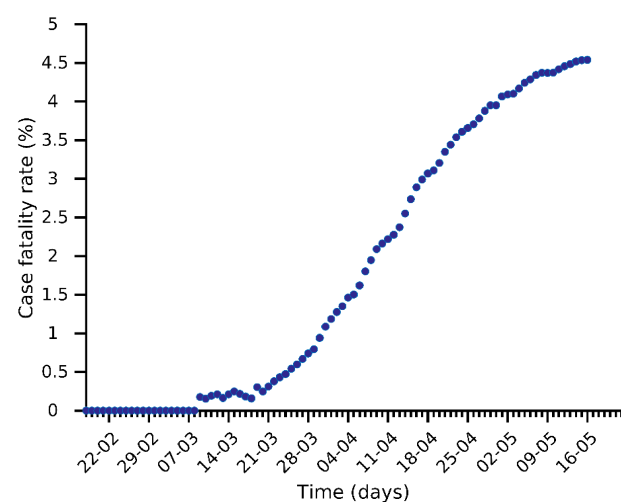
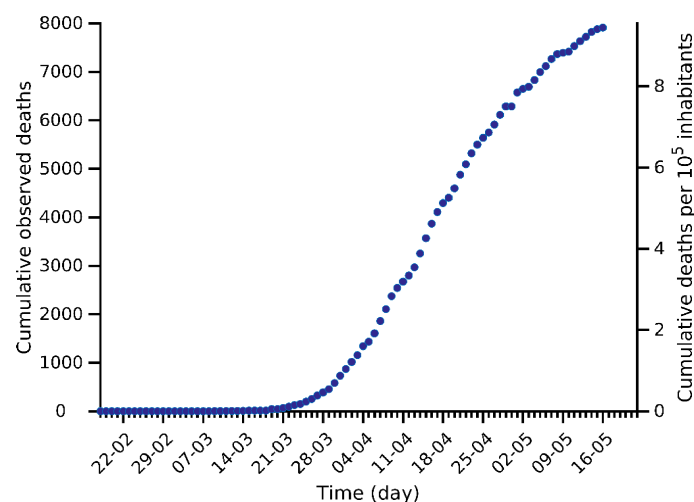
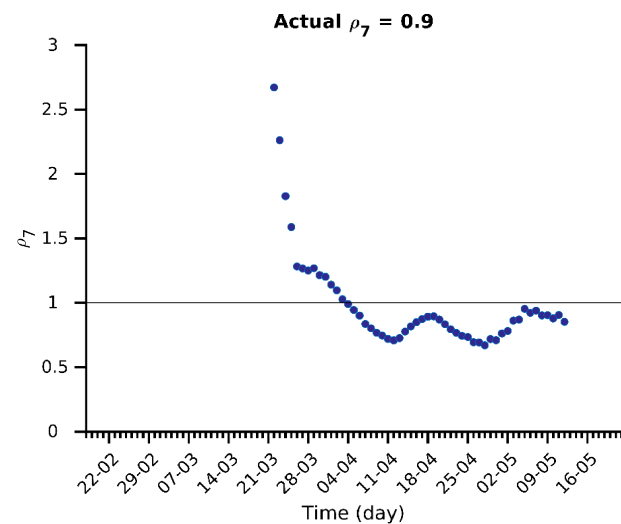
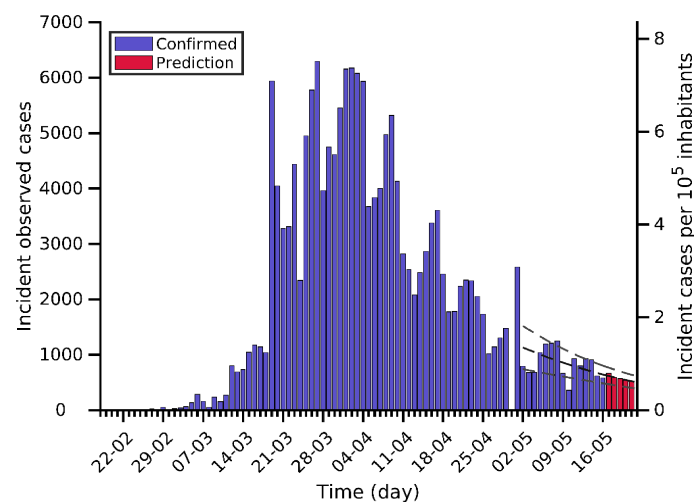
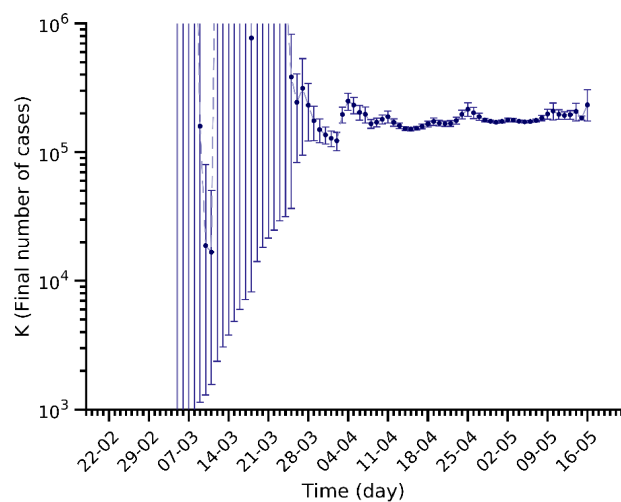
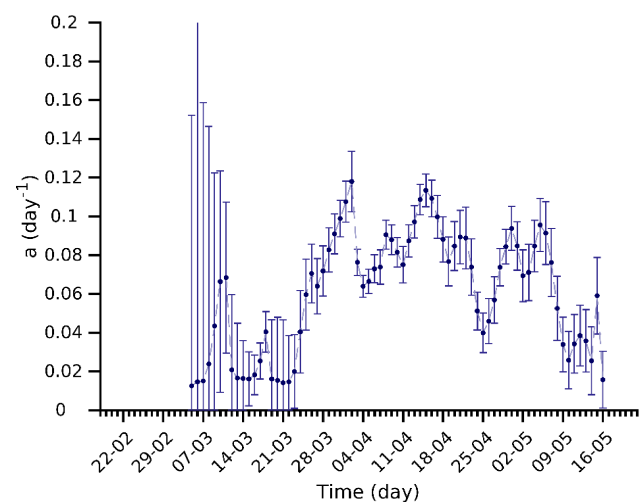
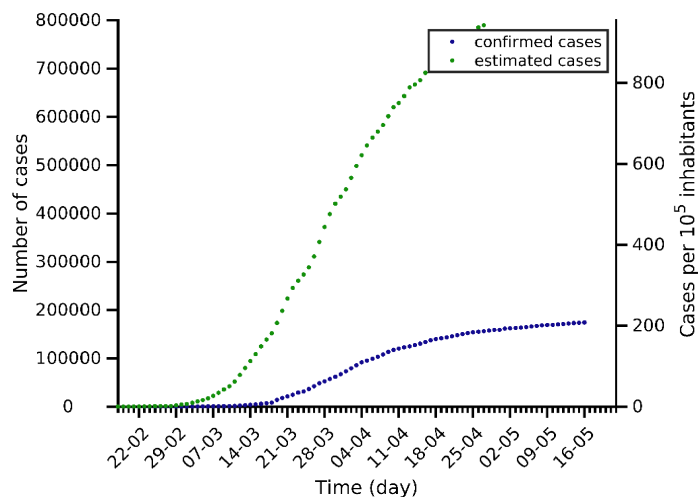
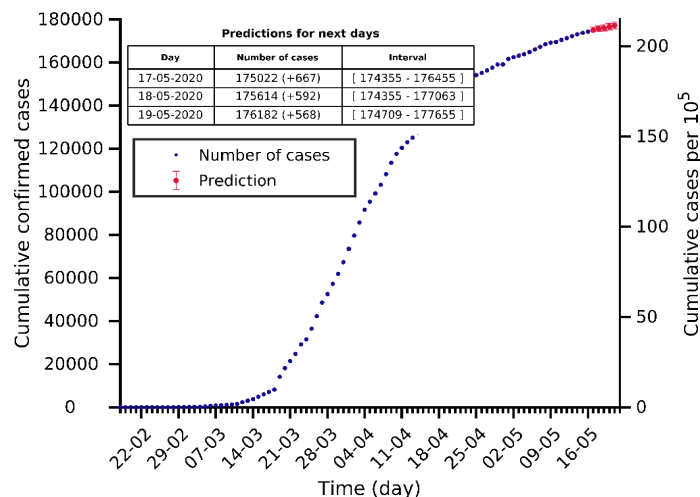
Spain 16-05-2020. Population: 47.0M. Current cumulated incidence: 486/10⁵



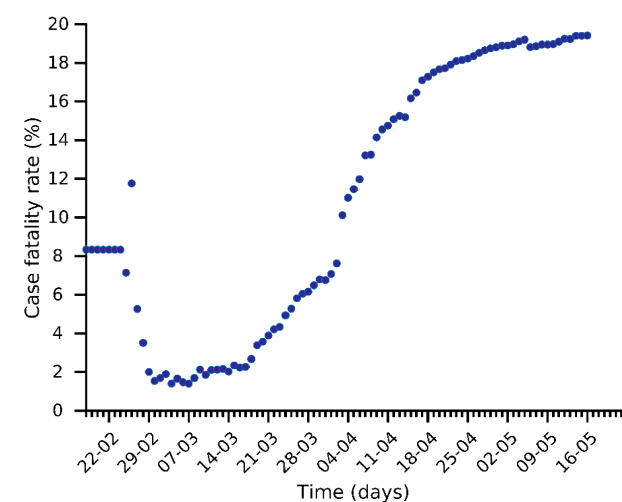
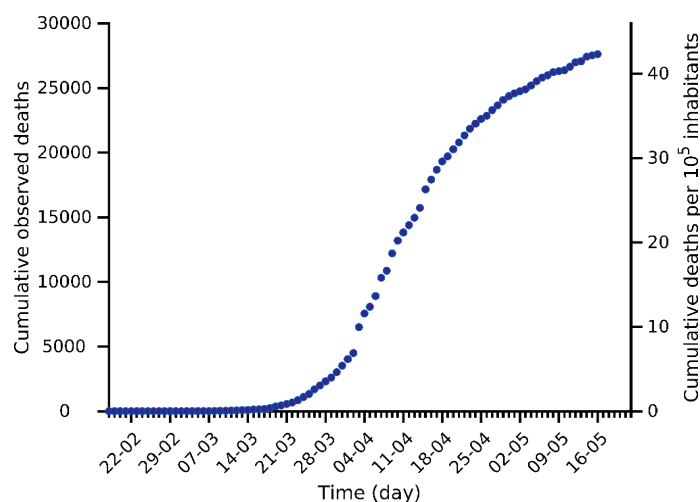
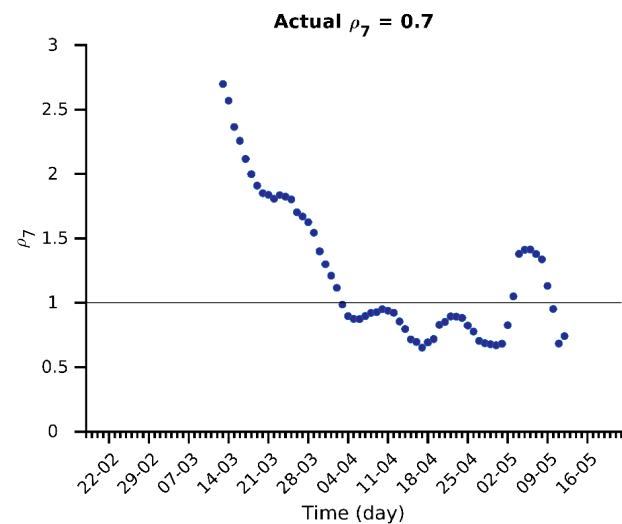
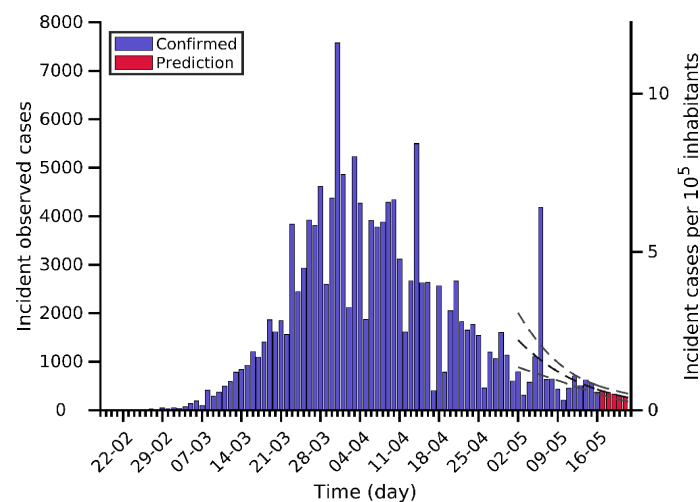
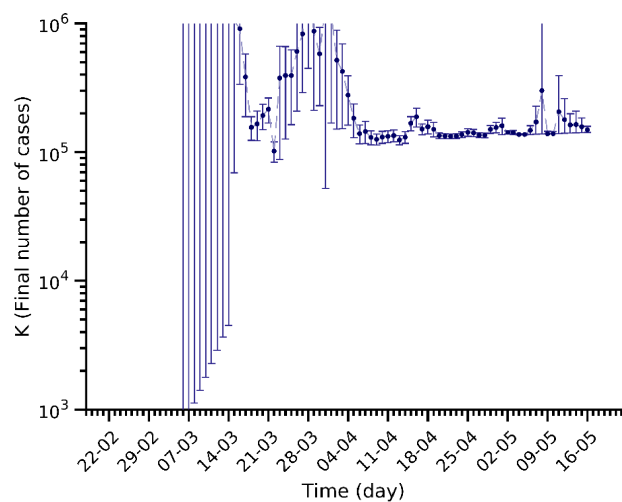
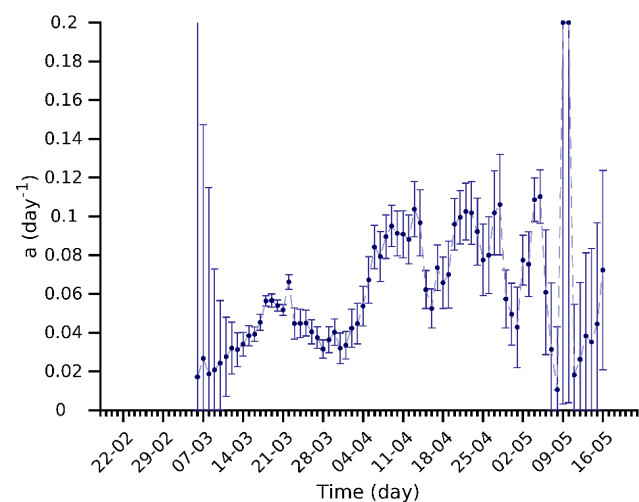
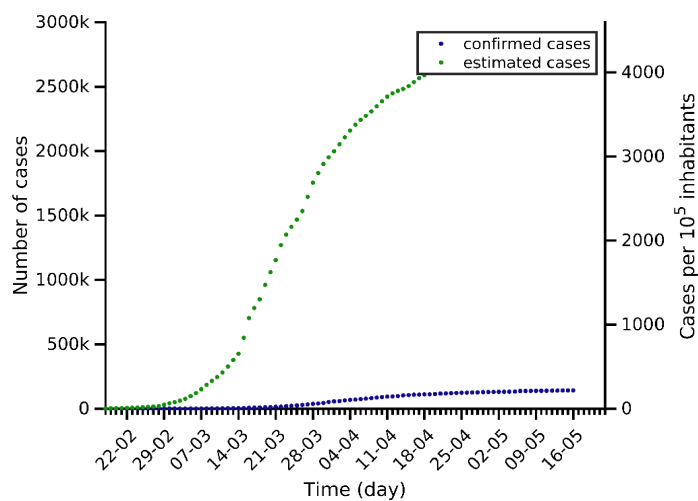
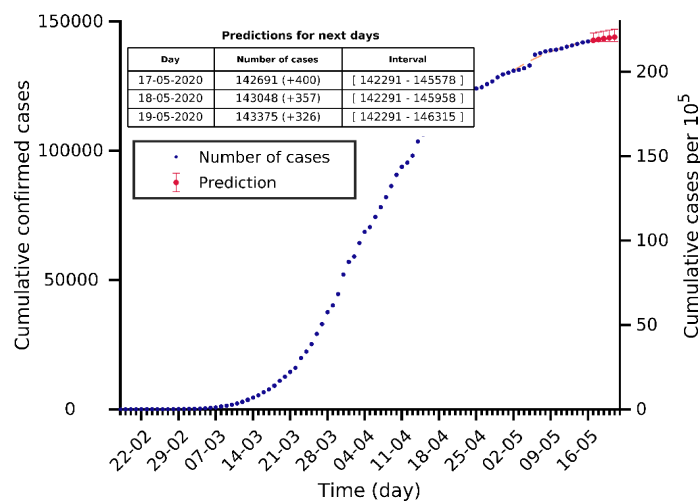
Italy 16-05-2020. Population: 60.5M. Current cumulated incidence: 372/10⁵



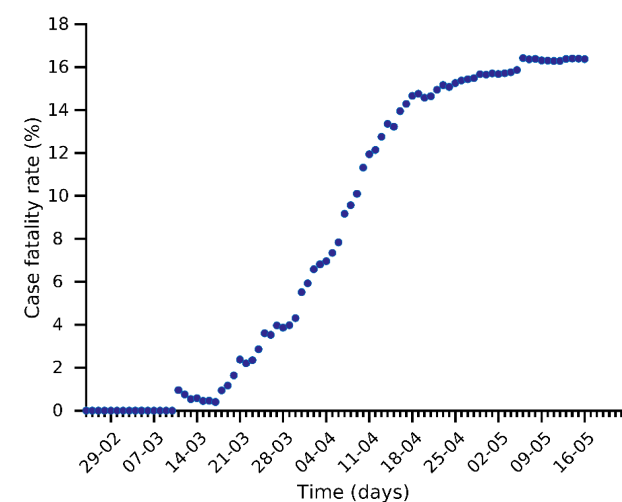
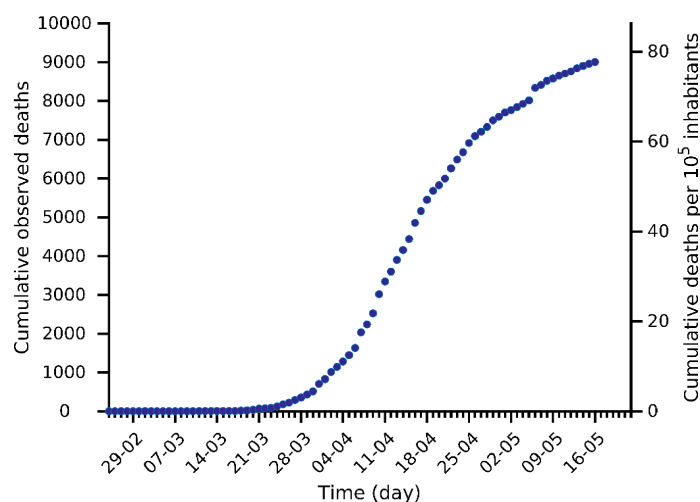
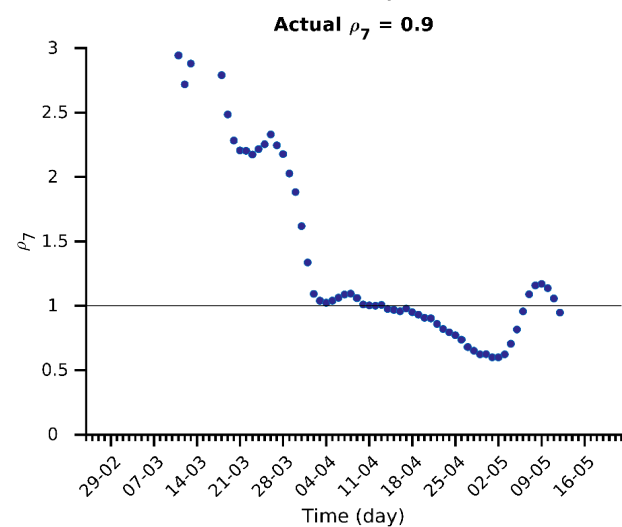
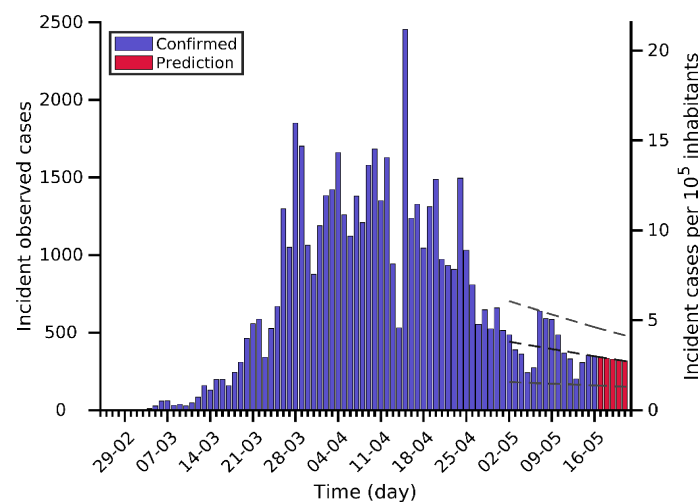
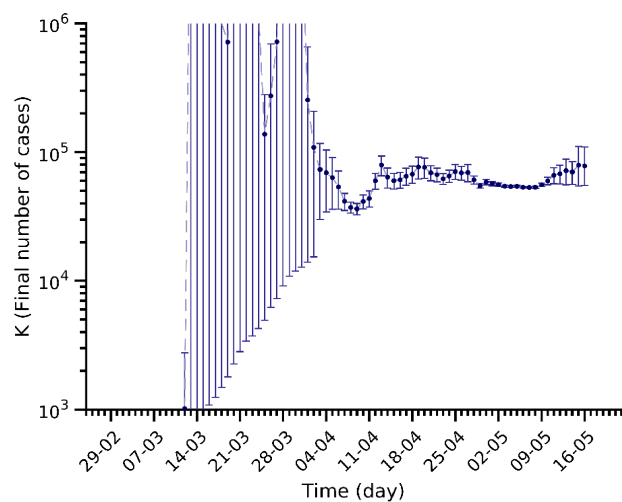
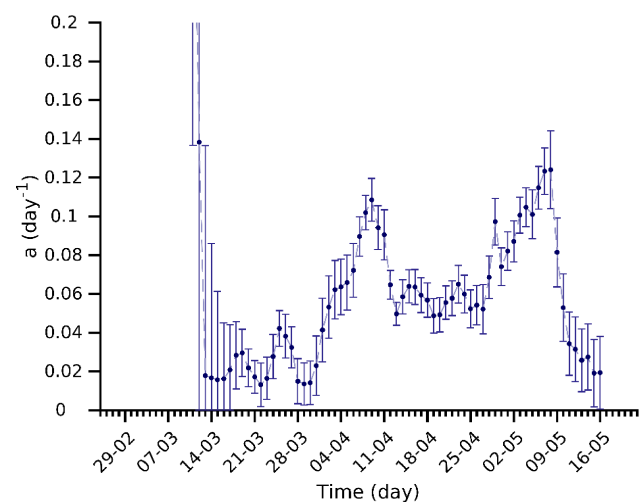
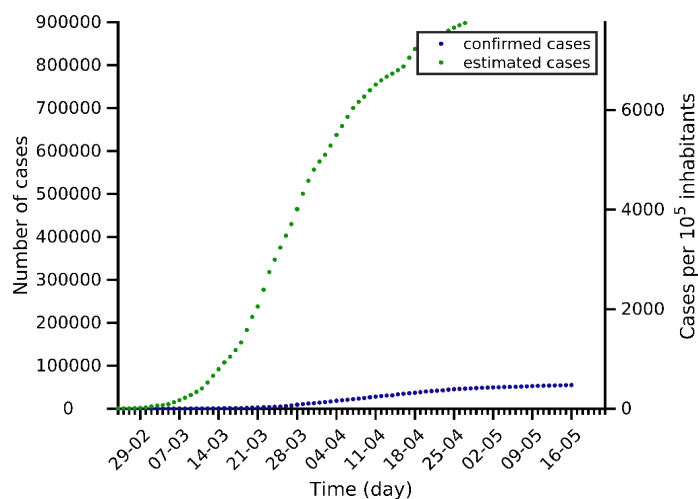
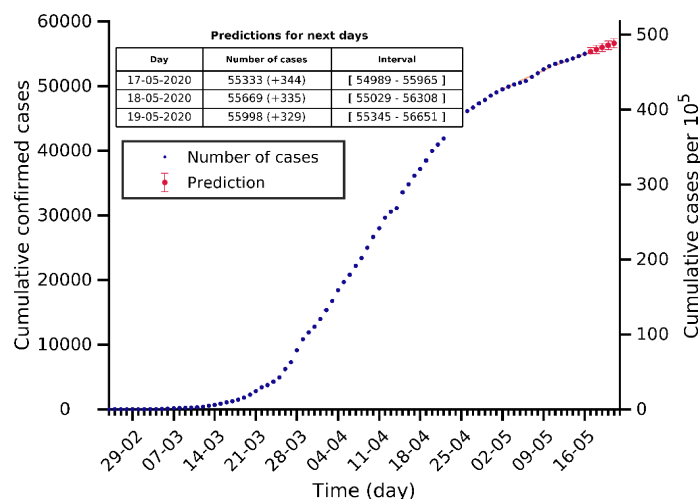
Germany 16-05-2020. Population: 83.8M. Current cumulated incidence: 208/10⁵



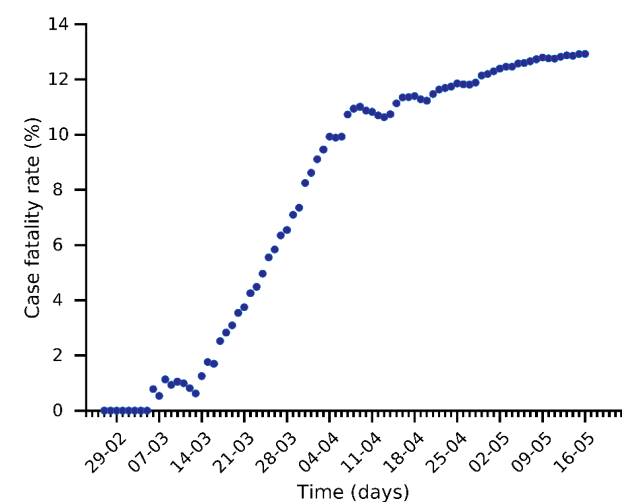
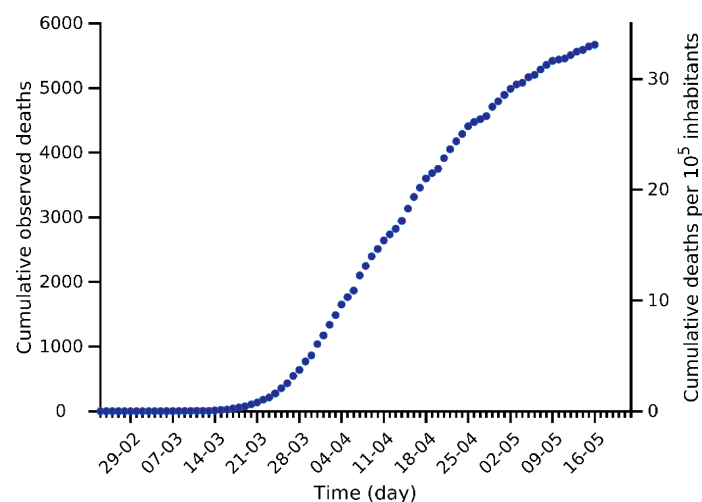
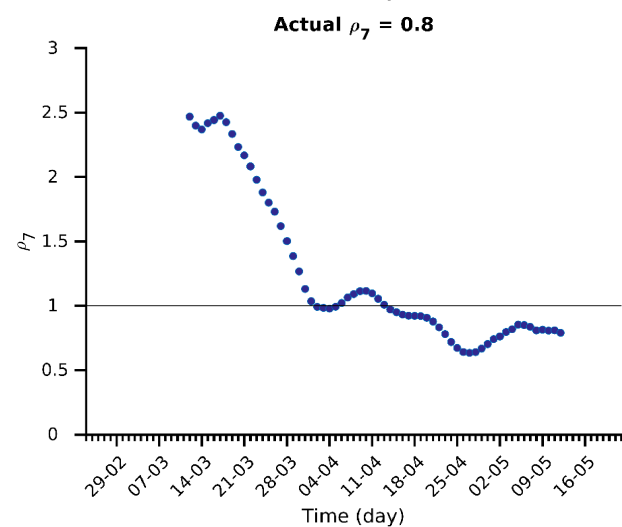
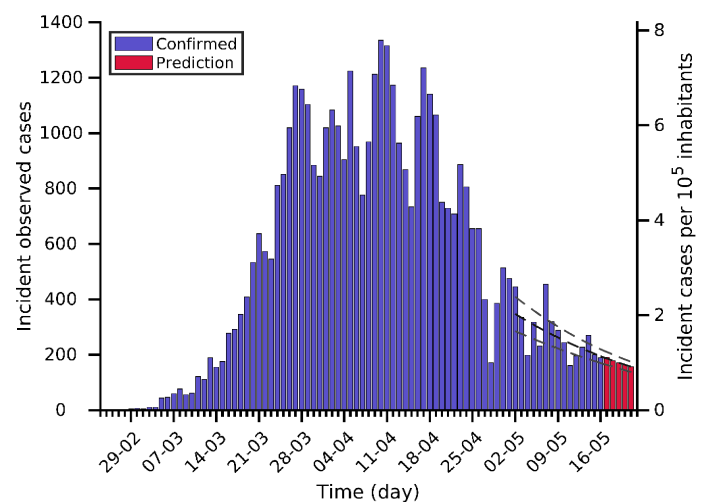
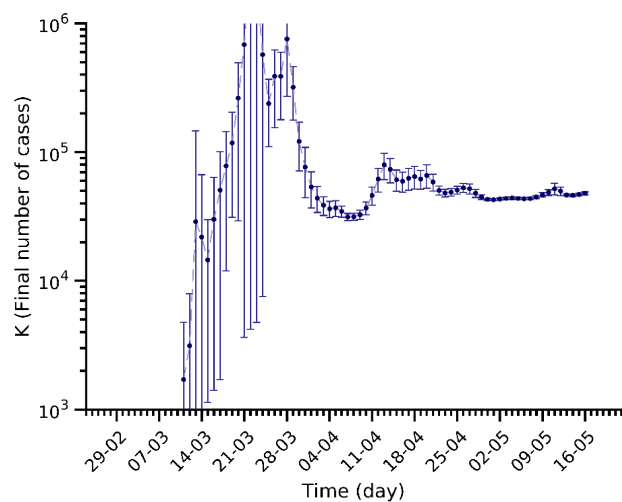
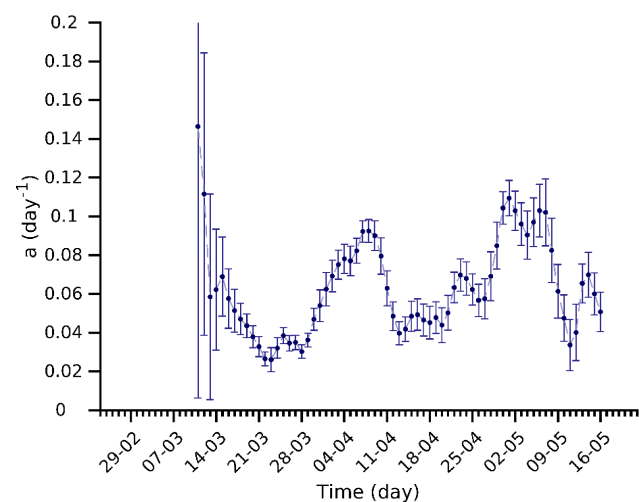
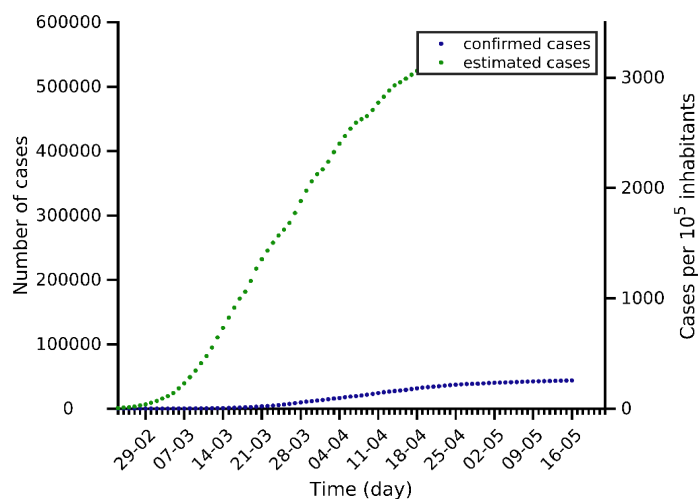
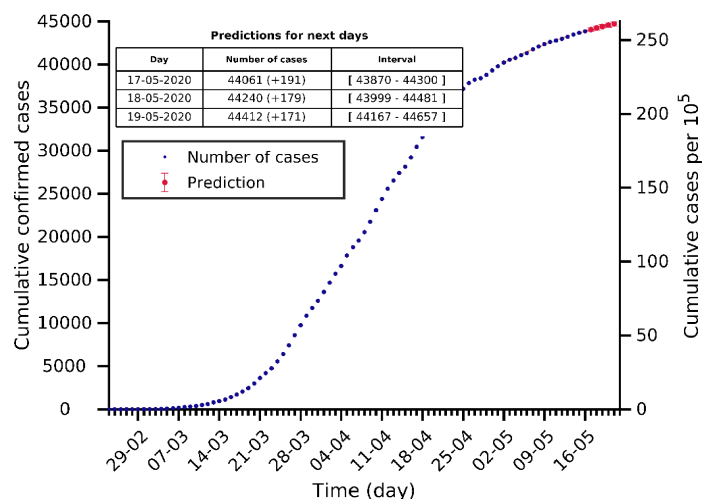
France 16-05-2020. Population: 65.3M. Current cumulated incidence: 218/10⁵



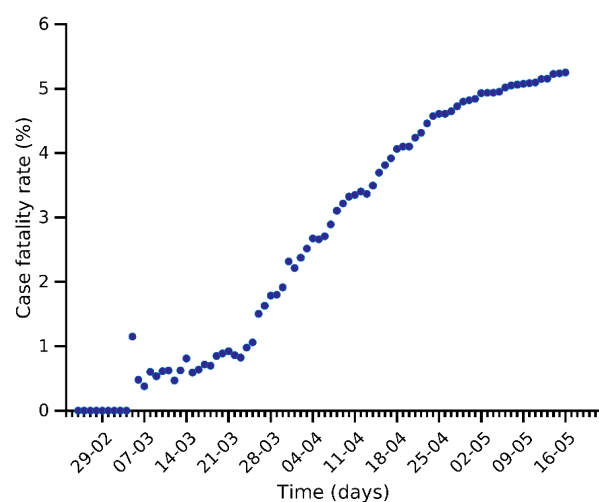
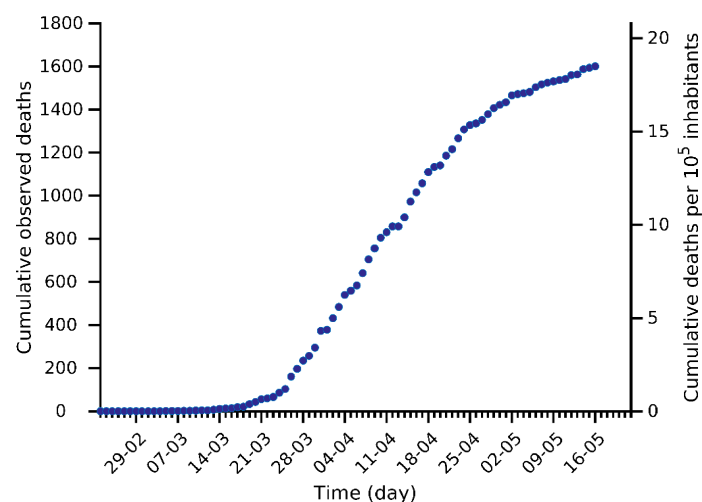
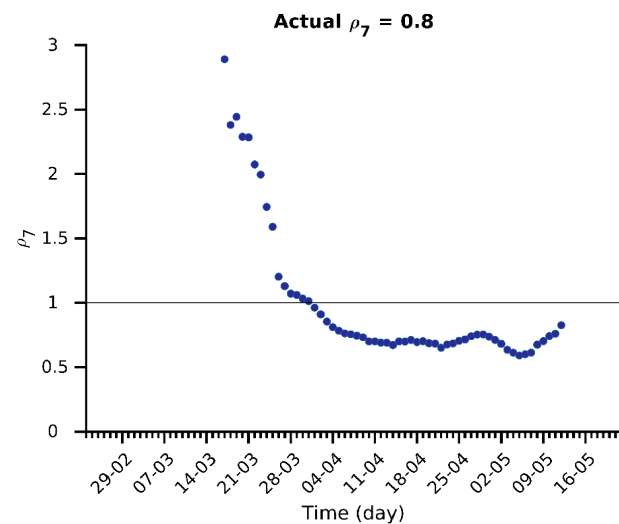
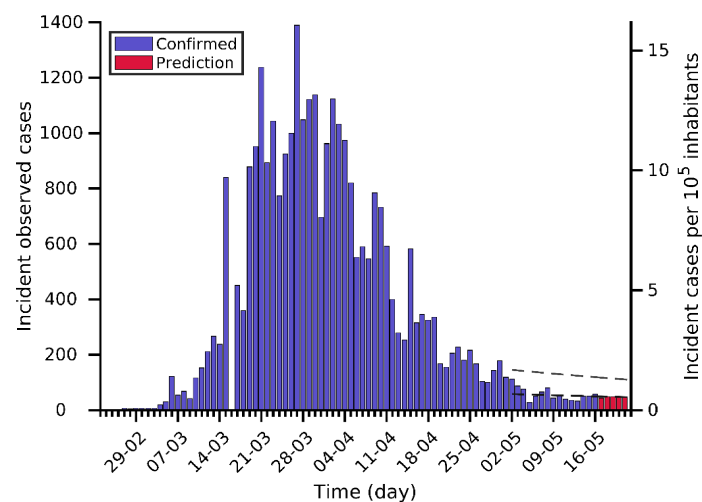
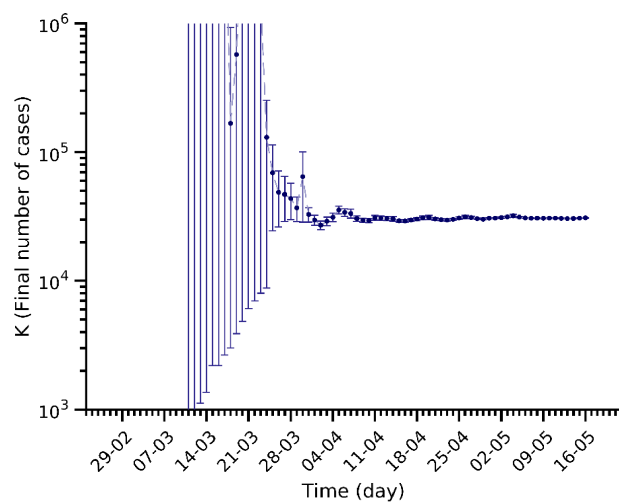
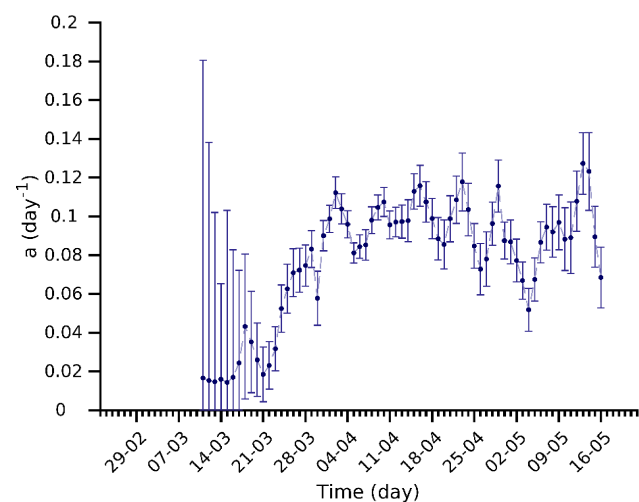
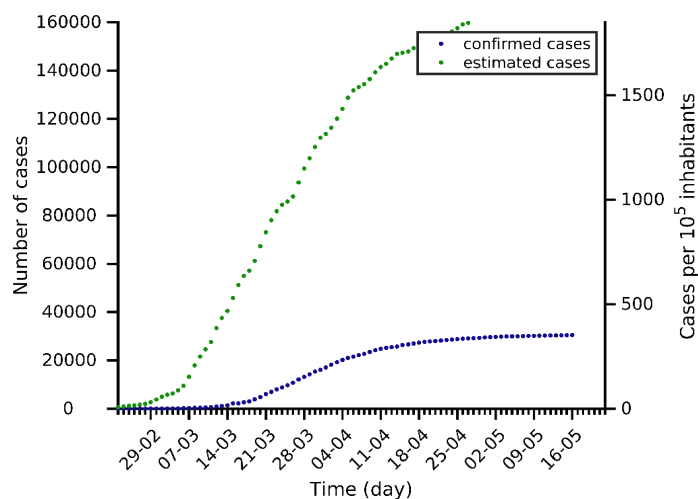
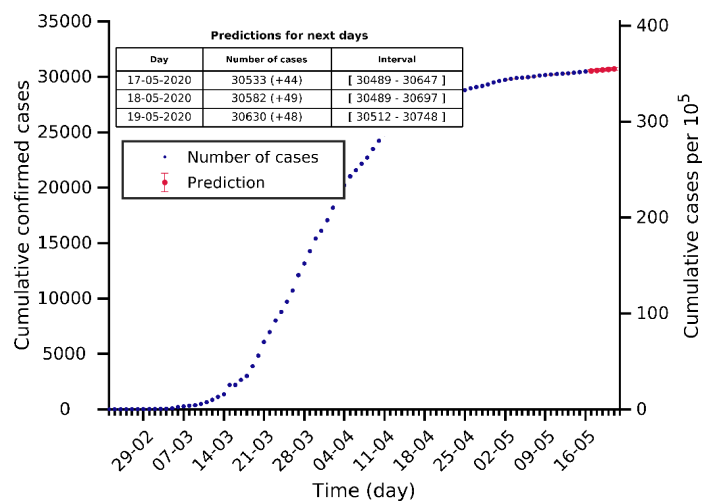
Belgium 16-05-2020. Population: 11.6M. Current cumulated incidence: 474/10⁵



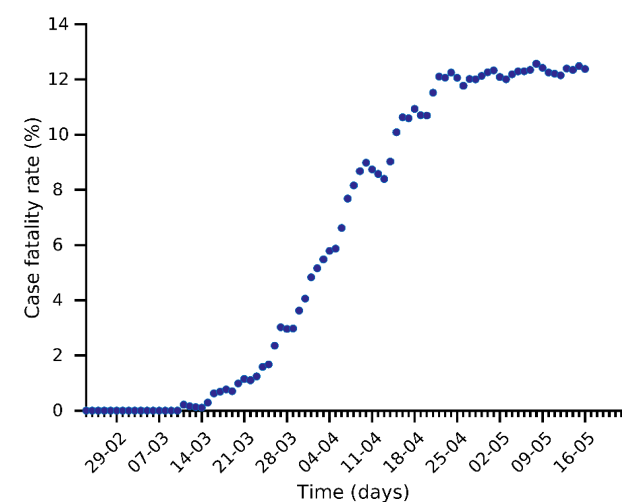
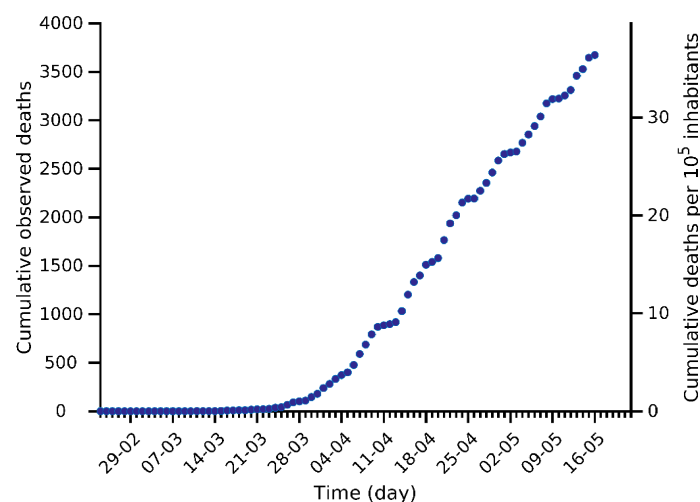
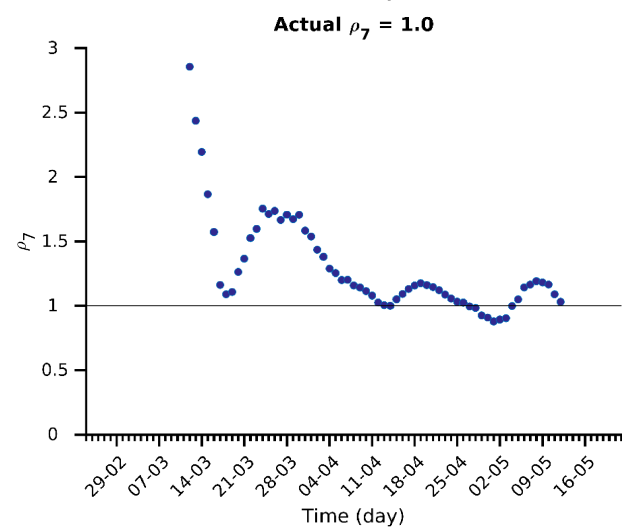
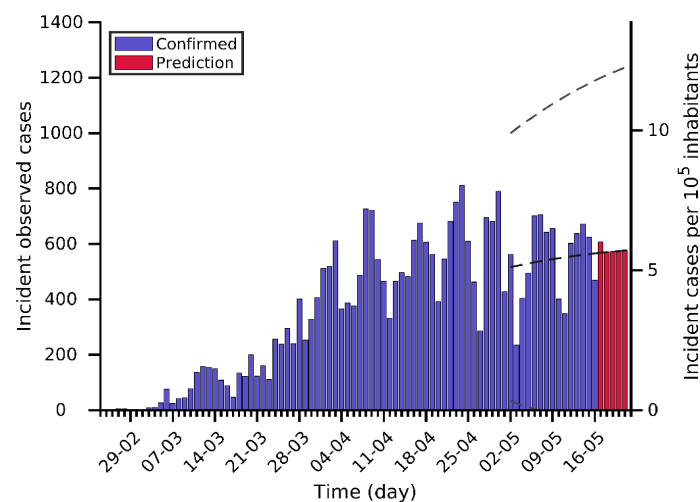
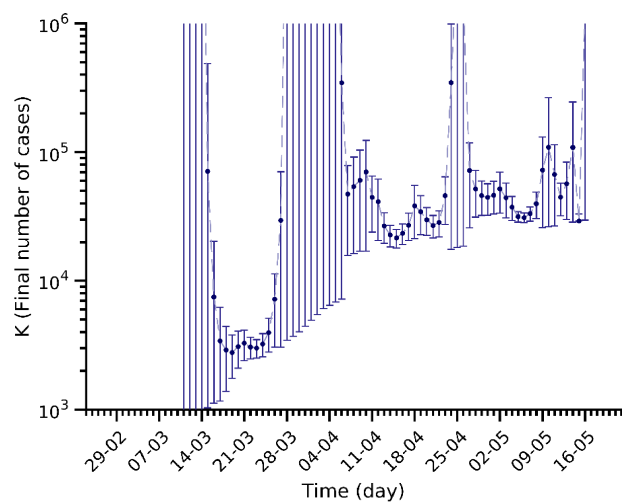
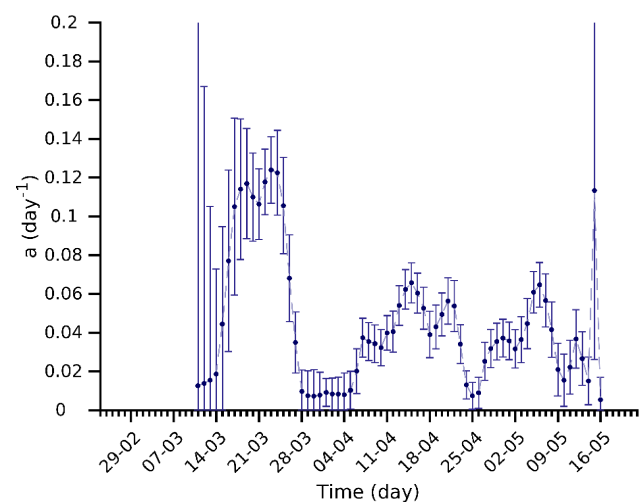
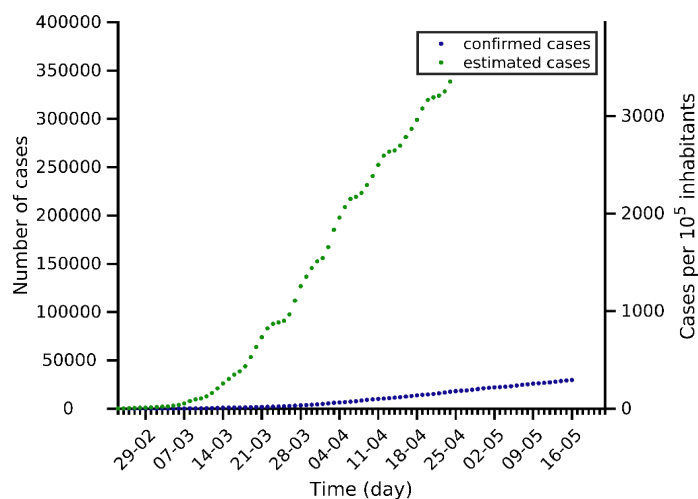
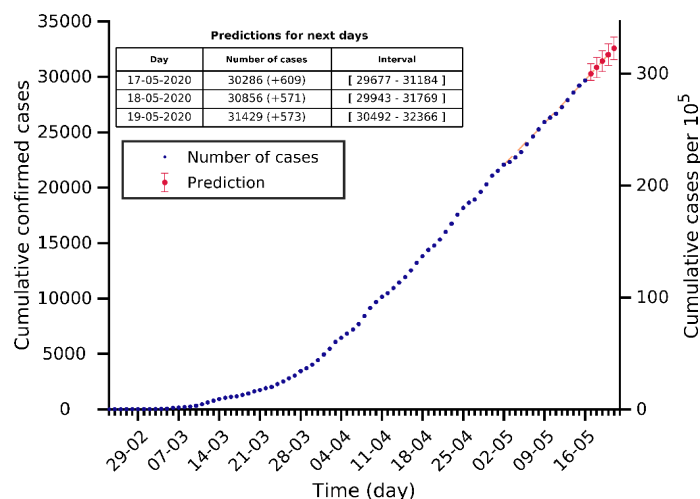
Netherlands 16-05-2020. Population: 17.1M. Current cumulated incidence: 256/10⁵



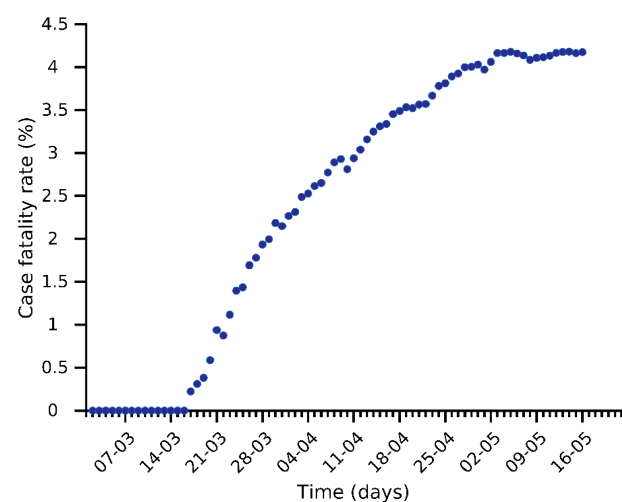
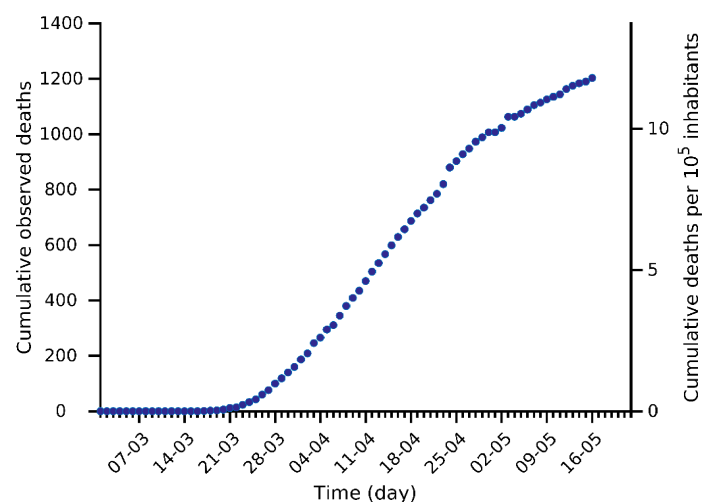
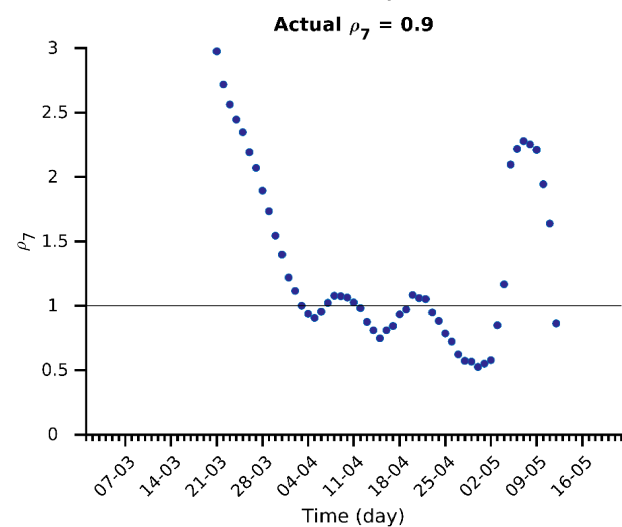
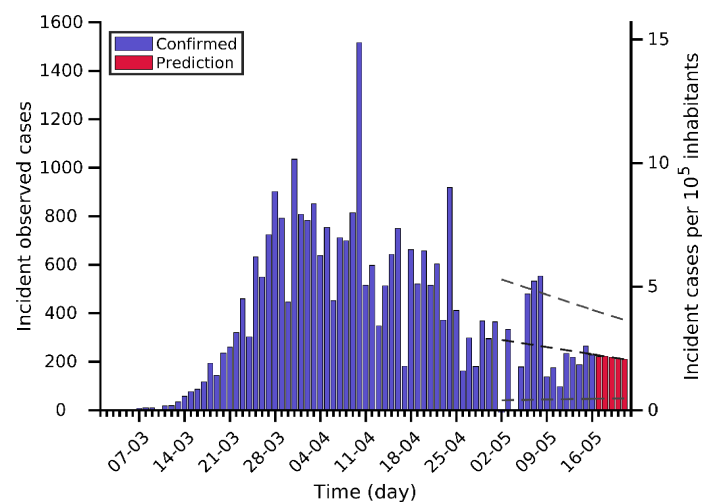
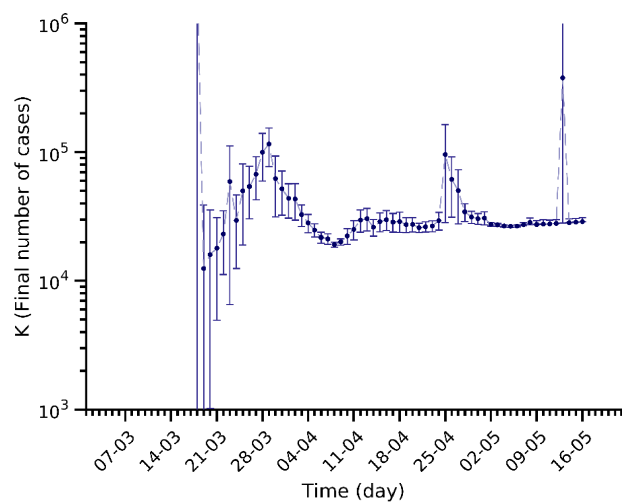
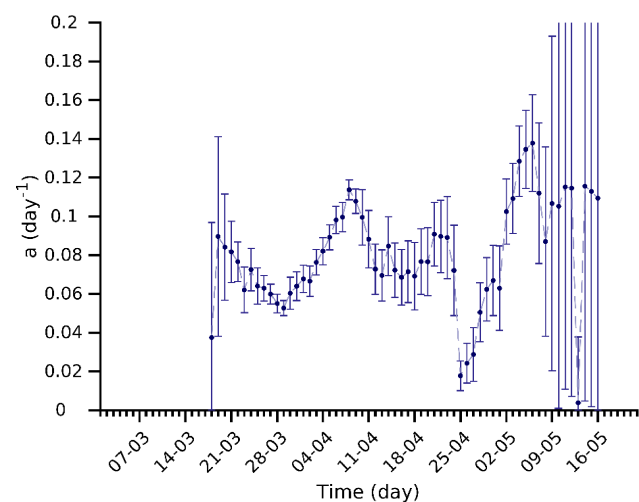
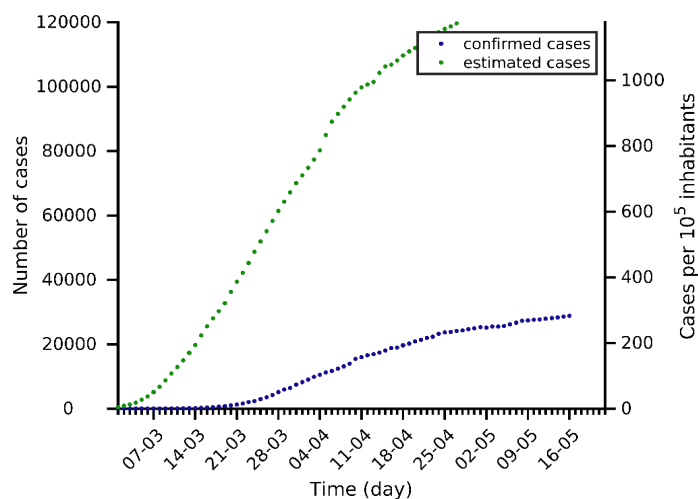
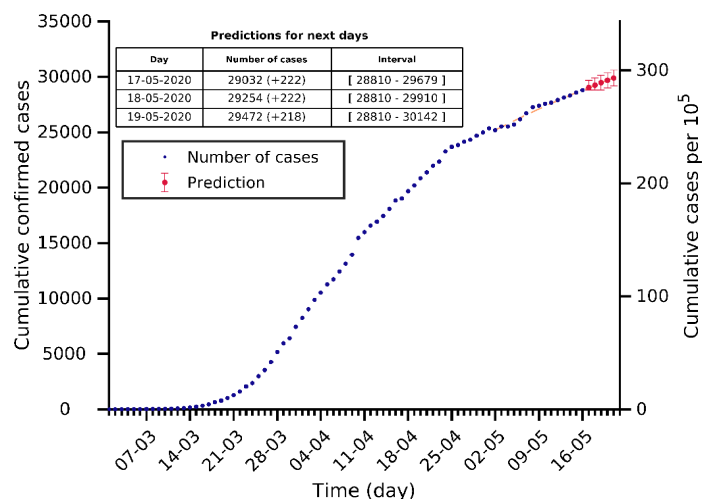
Switzerland 16-05-2020. Population: 8.7M. Current cumulated incidence: 352/10⁵



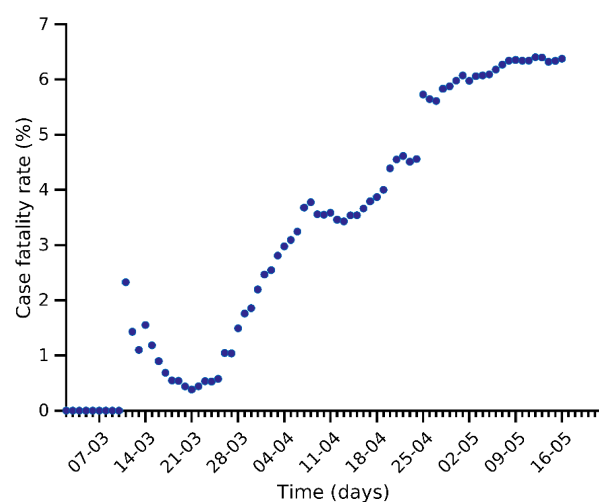
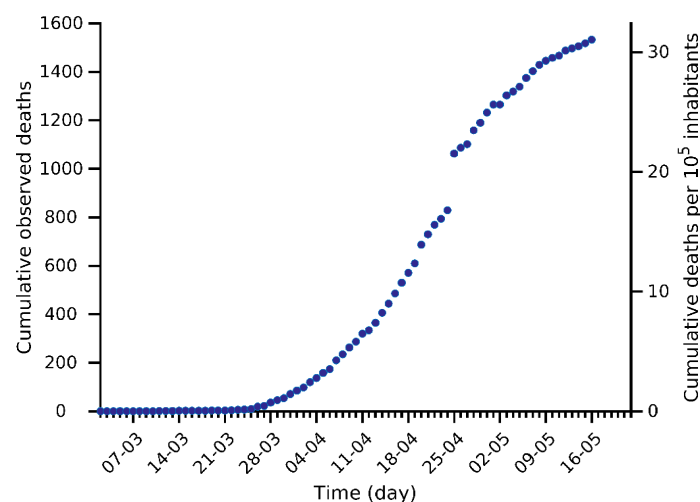
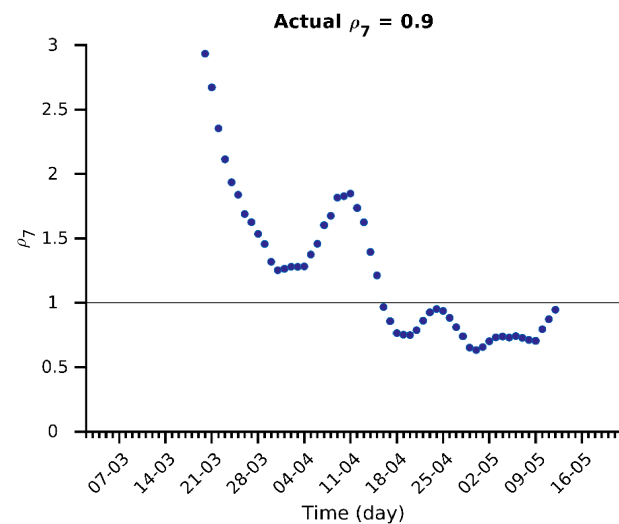
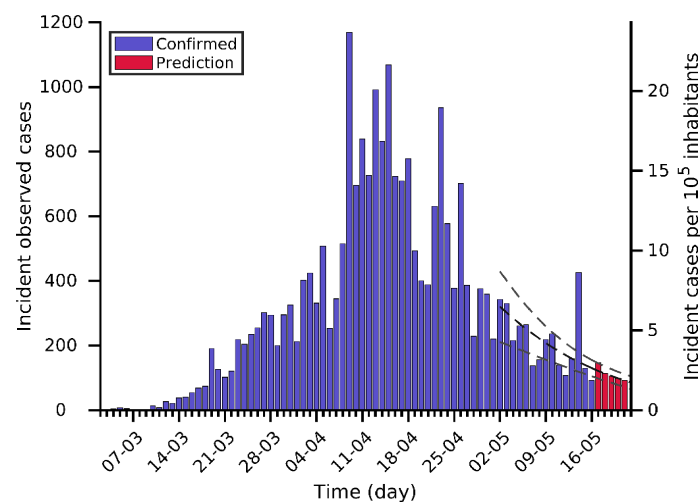
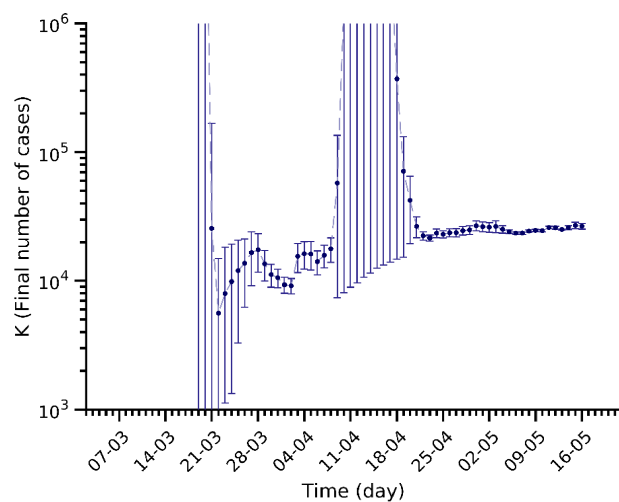
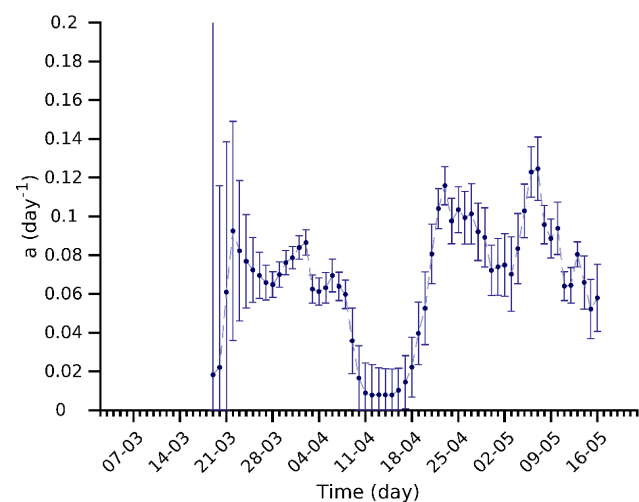
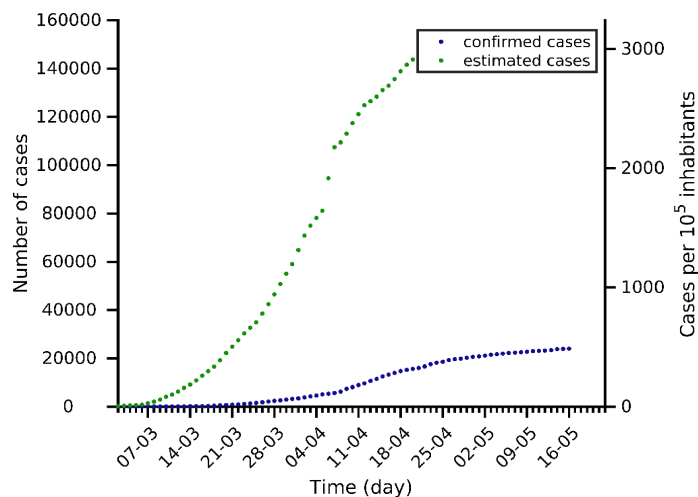
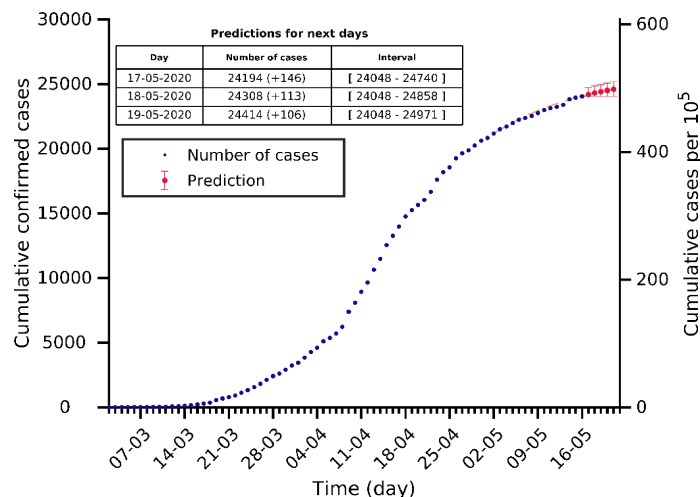
Sweden 16-05-2020. Population: 10.1M. Current cumulated incidence: 294/10⁵



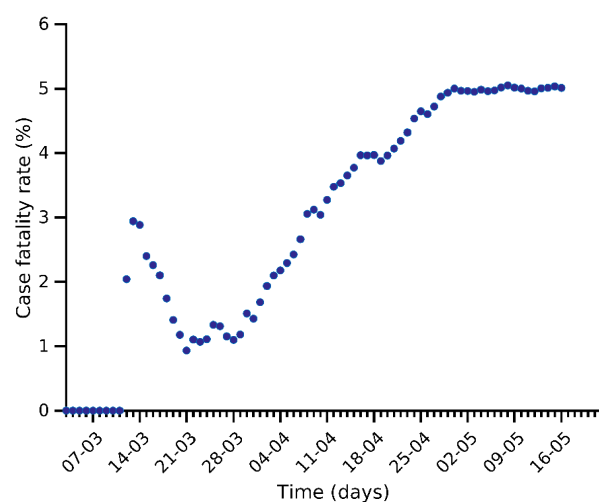
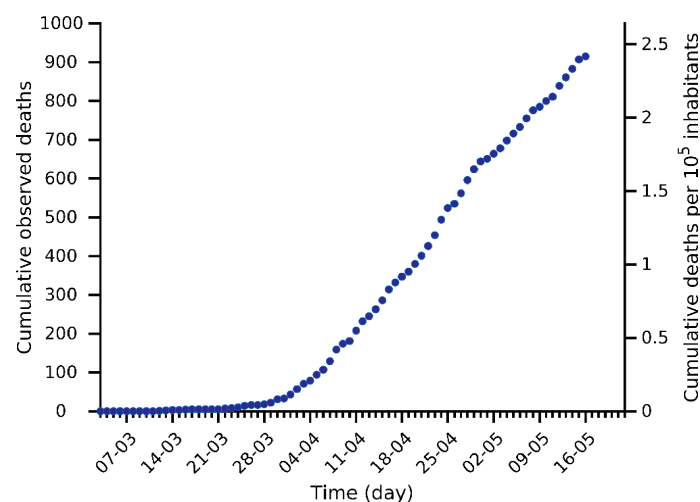
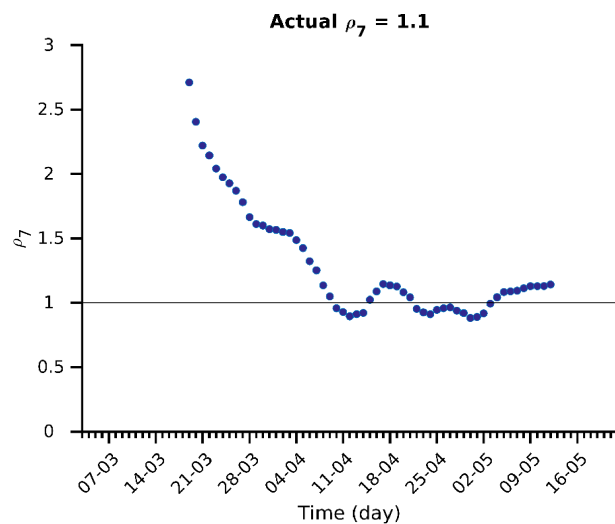
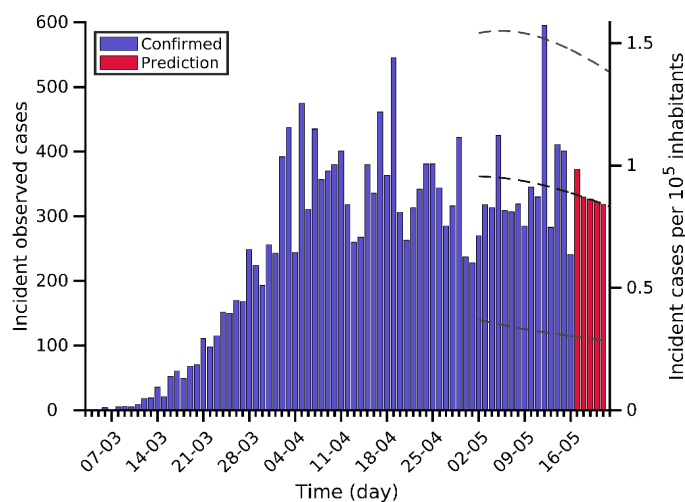
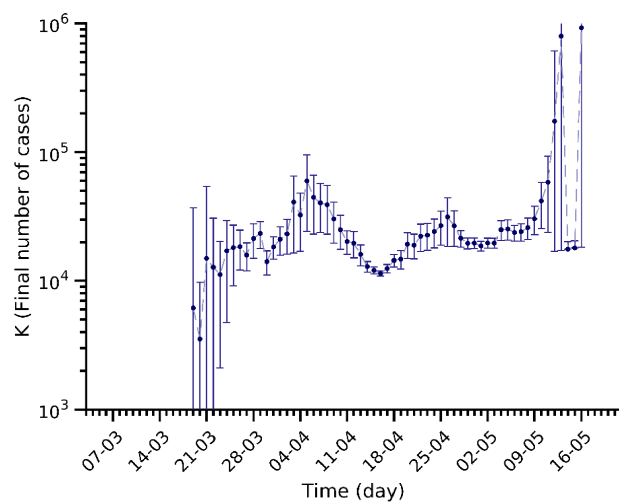
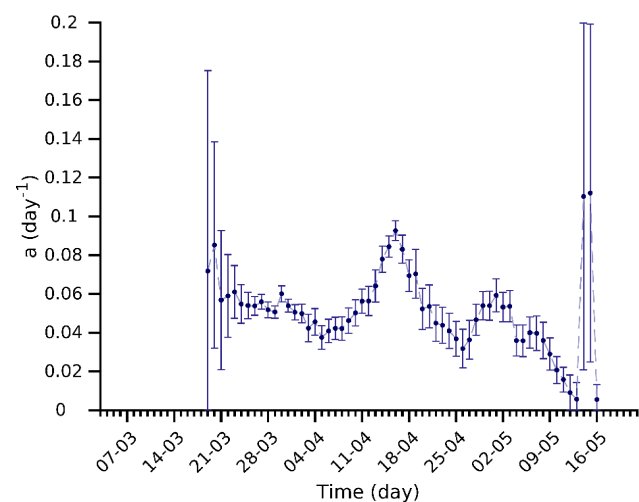
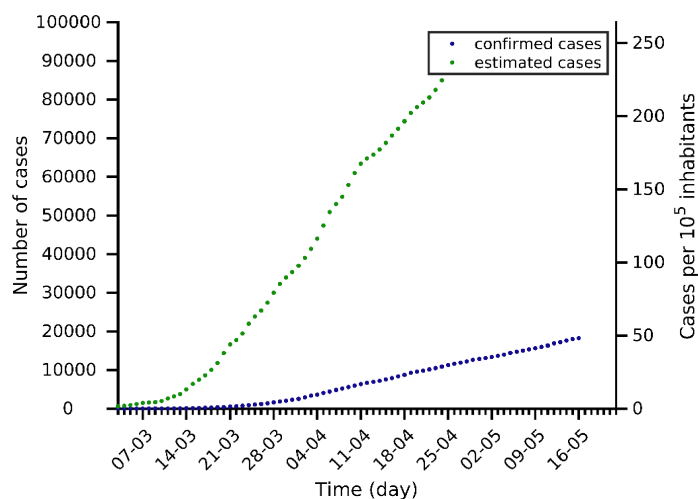
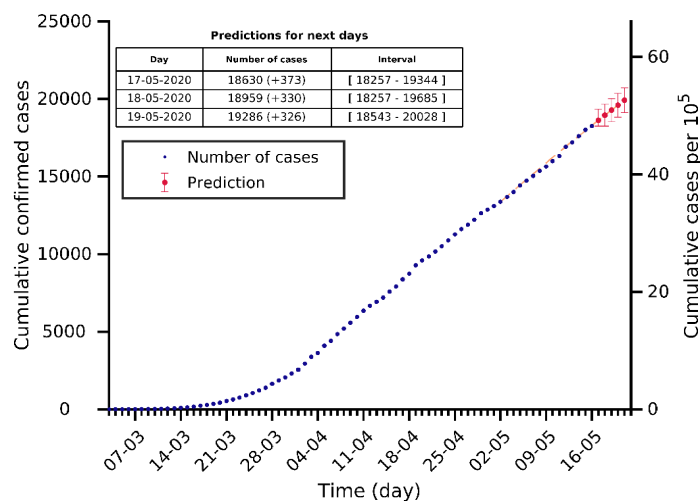
Portugal 16-05-2020. Population: 10.2M. Current cumulated incidence: 283/10⁵



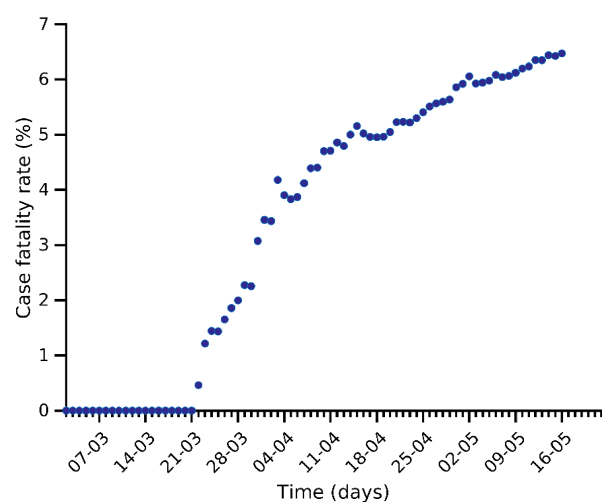
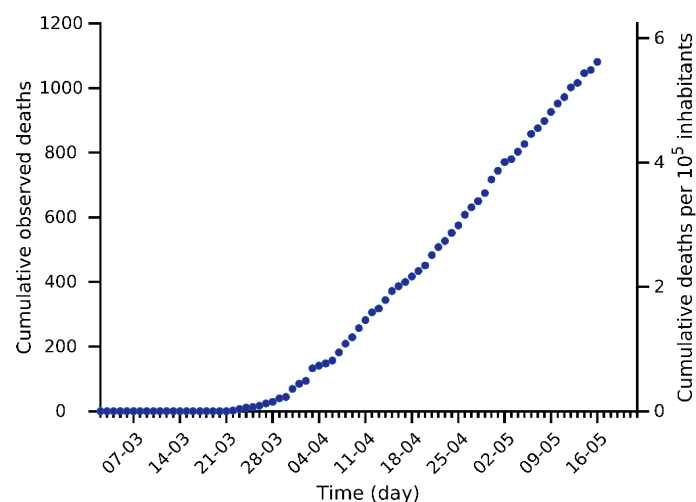
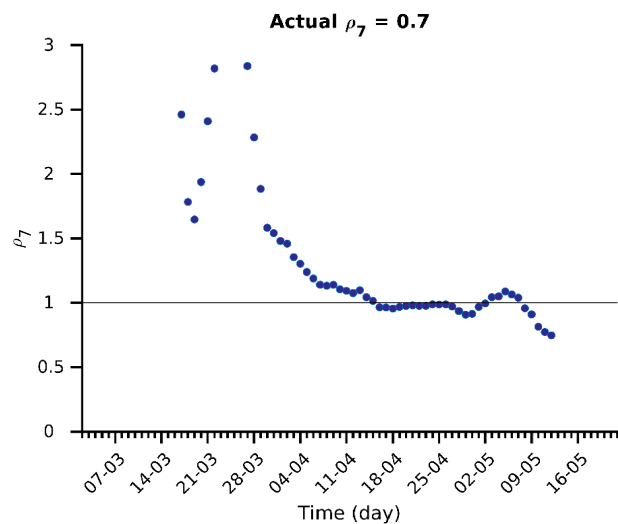
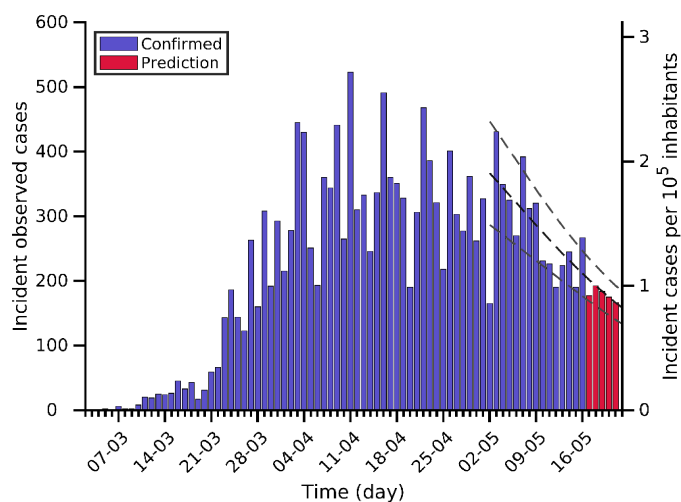
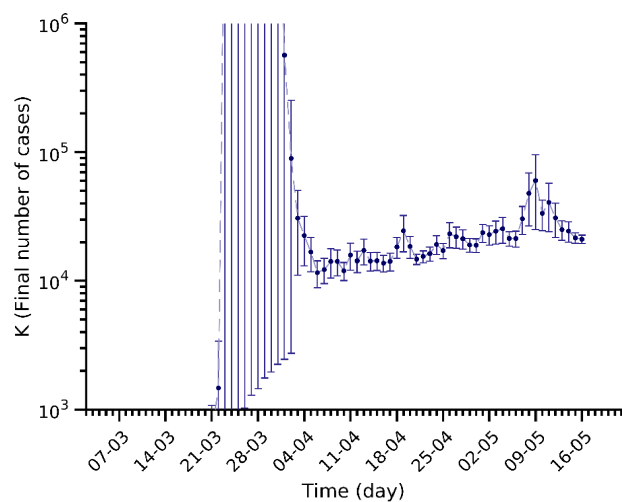
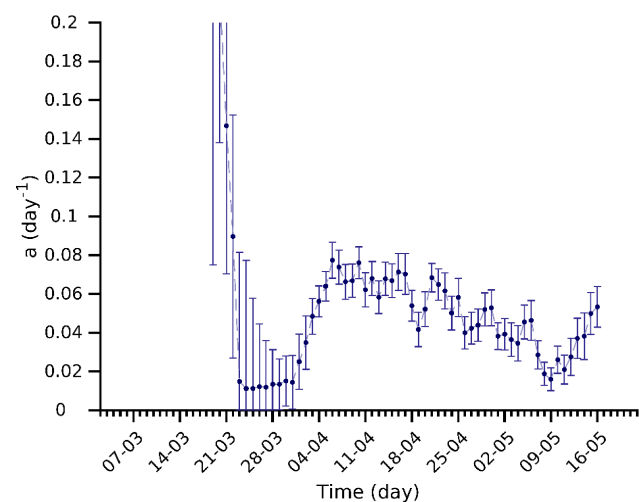
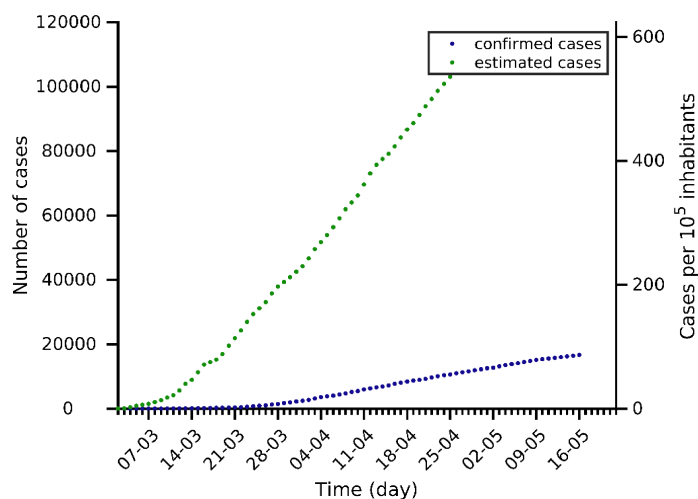
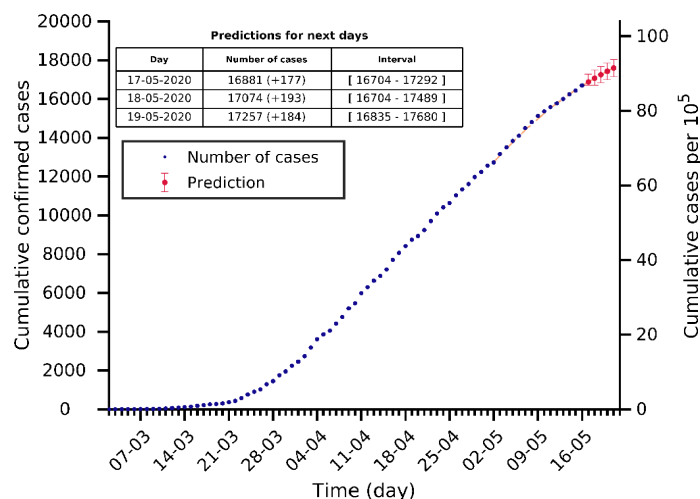
Ireland 16-05-2020. Population: 4.9M. Current cumulated incidence: 487/10⁵



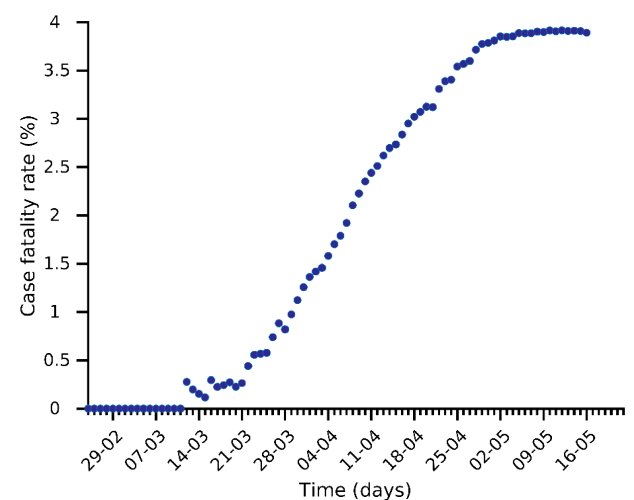
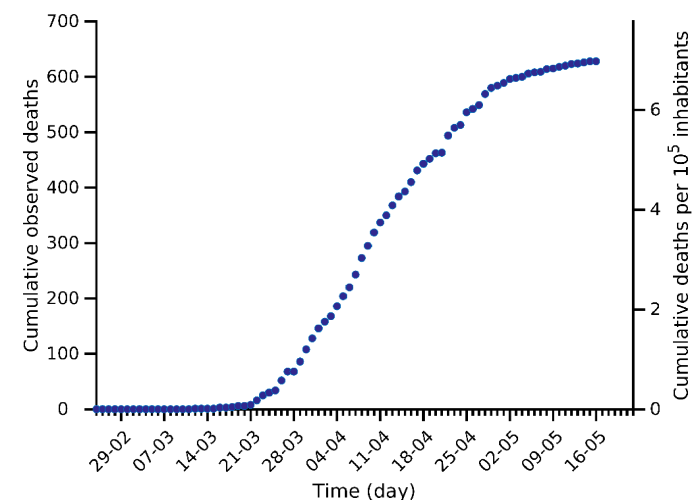
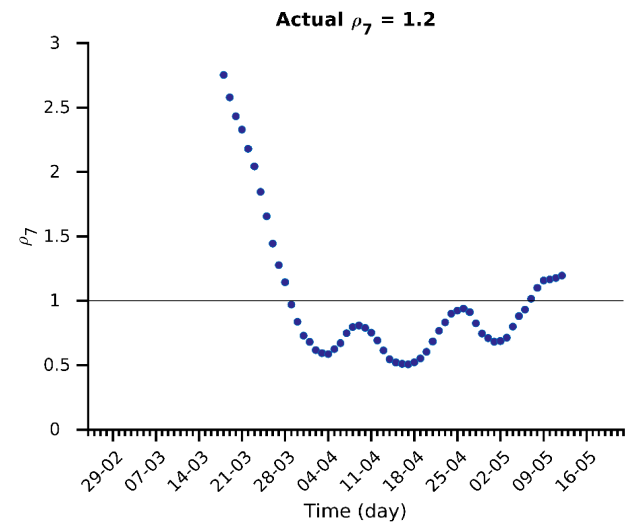
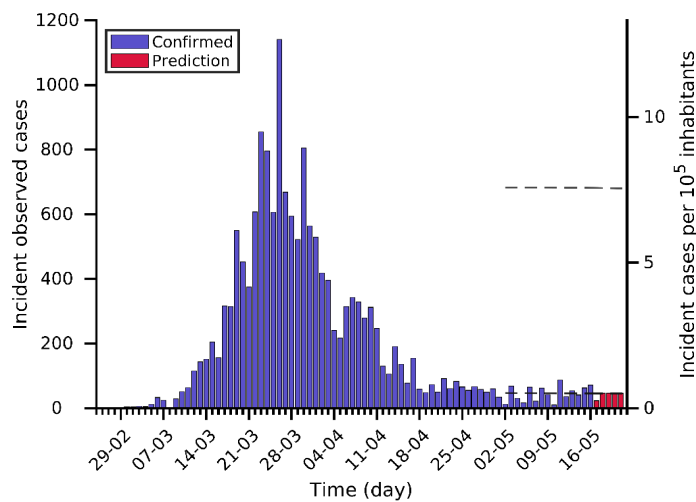
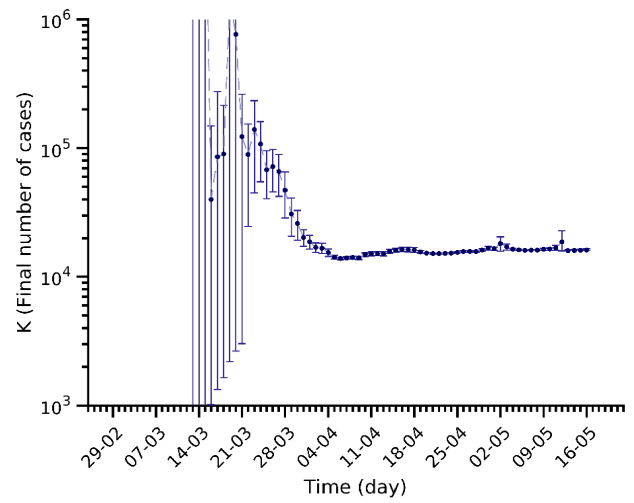
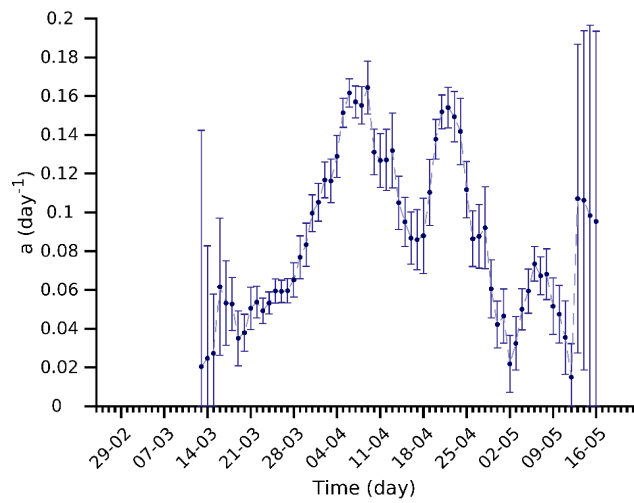
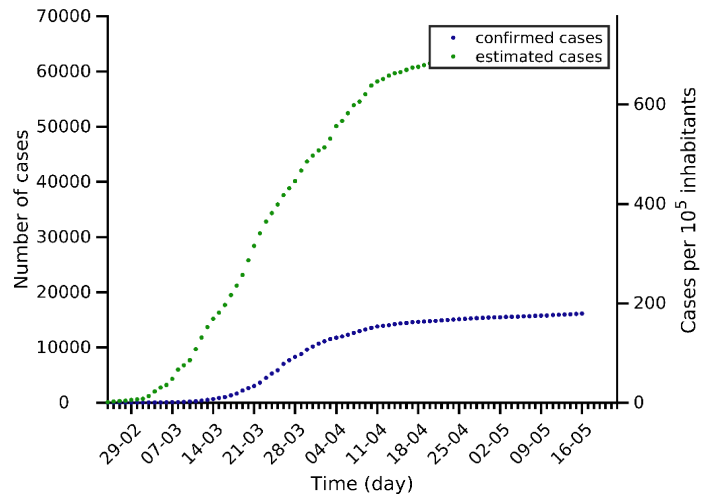
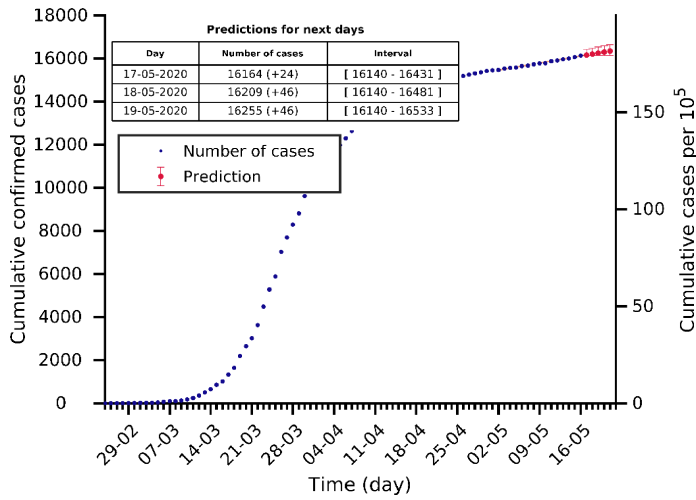
Poland 16-05-2020. Population: 37.8M. Current cumulated incidence: 48/10⁵



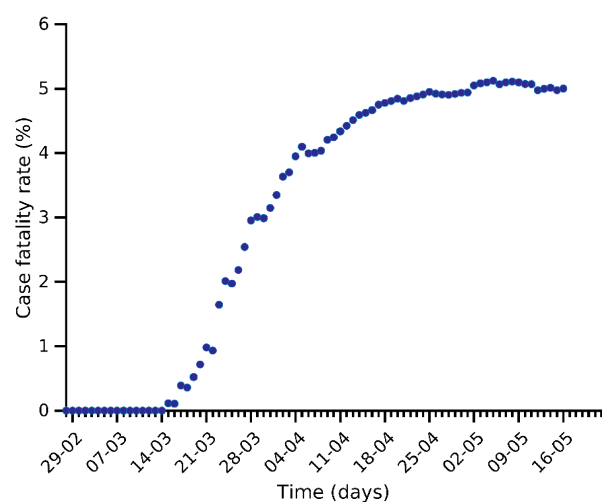
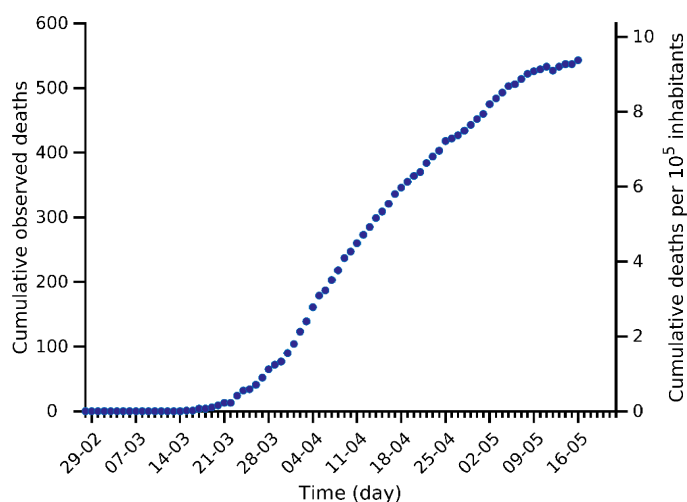
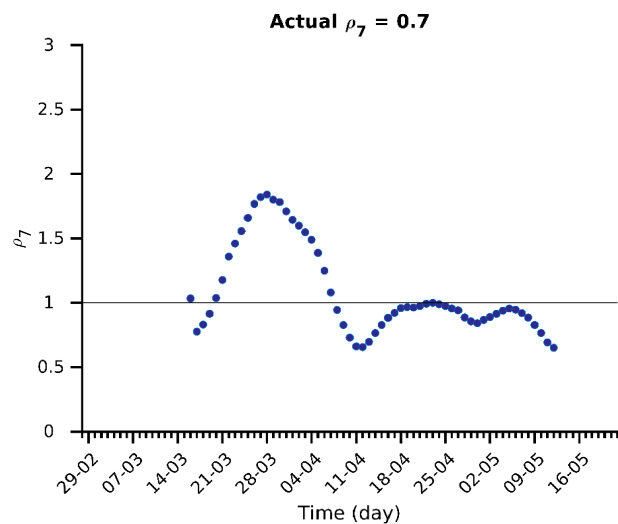
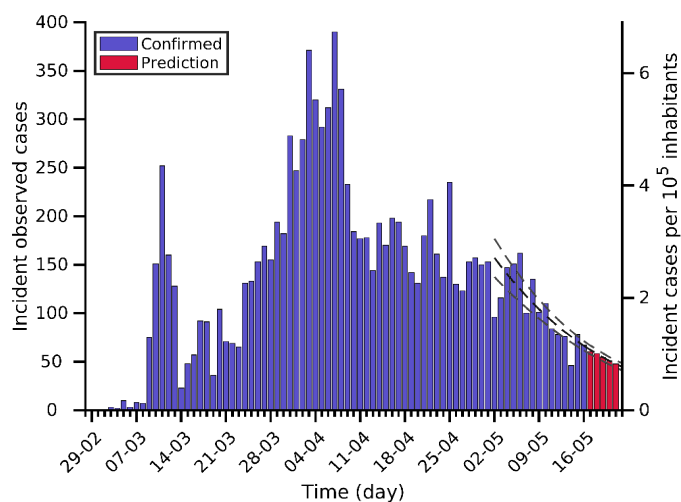
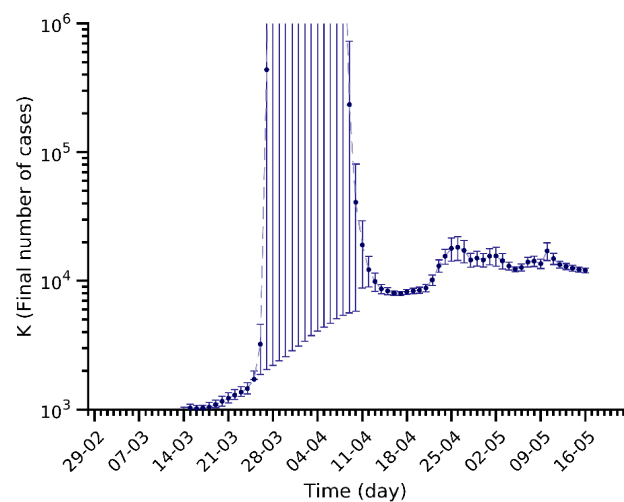
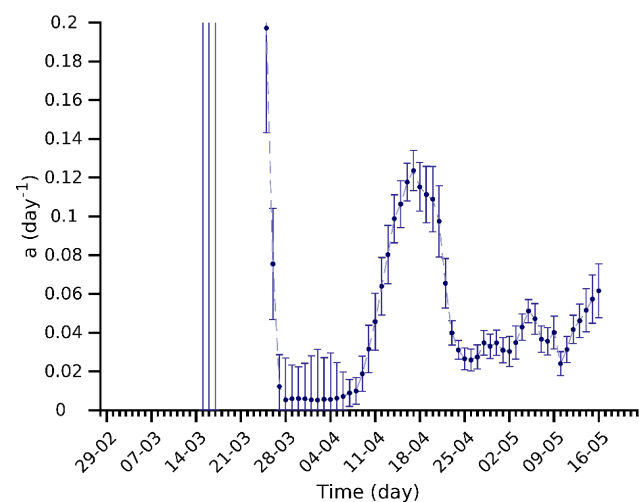
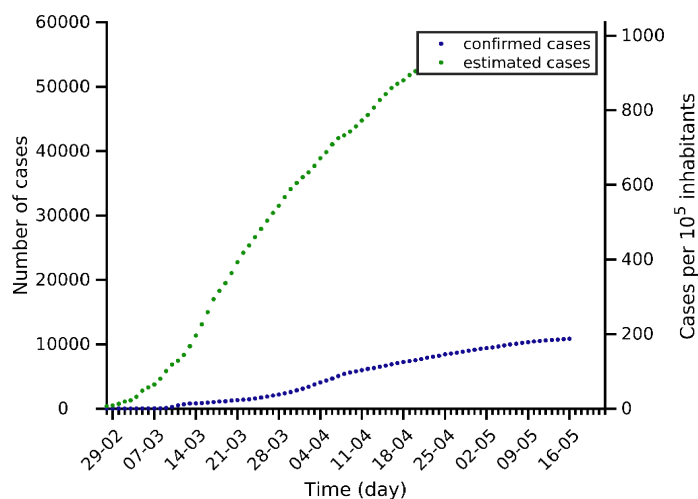
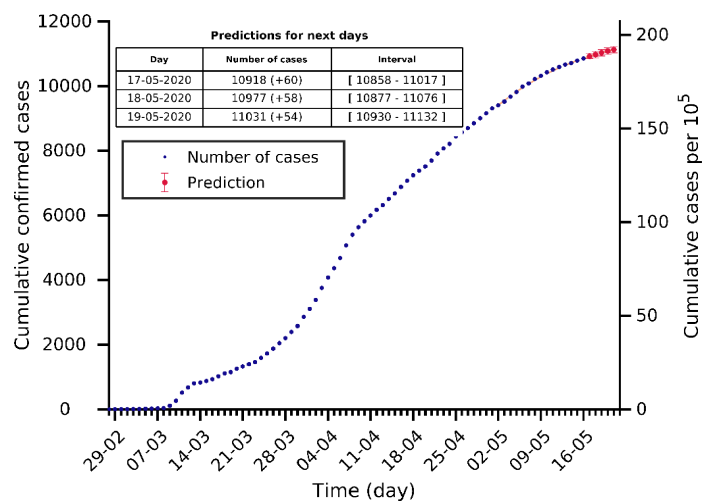
Romania 16-05-2020. Population: 19.2M. Current cumulated incidence: 87/10⁵



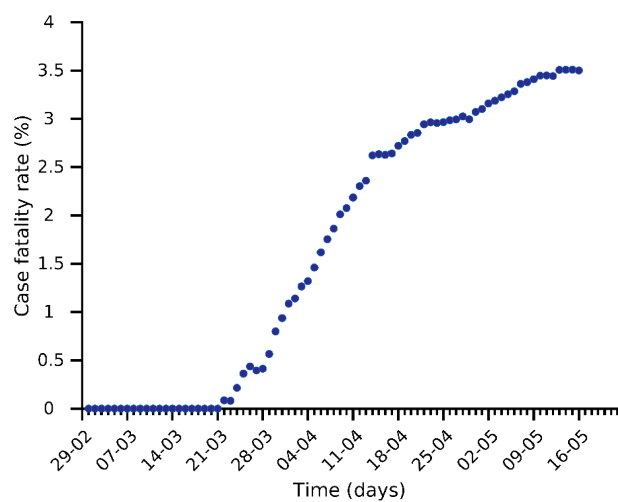
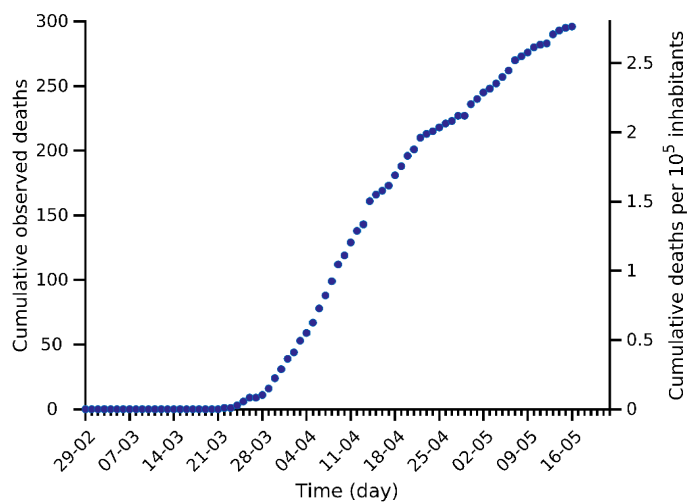
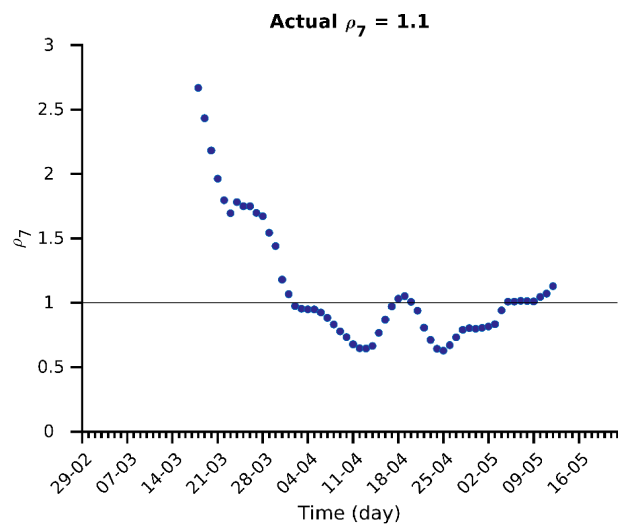
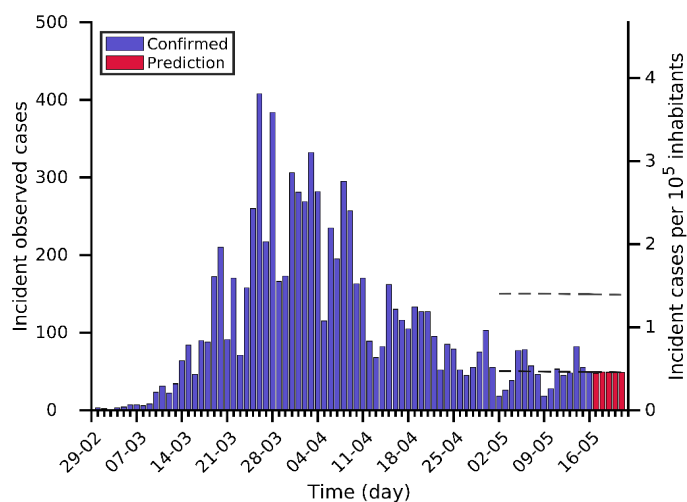
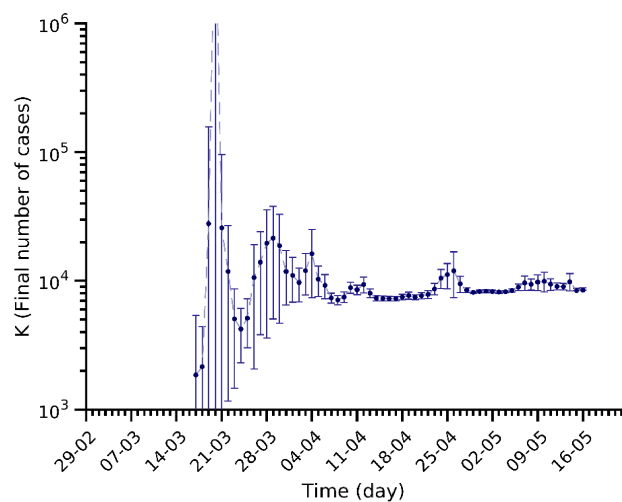
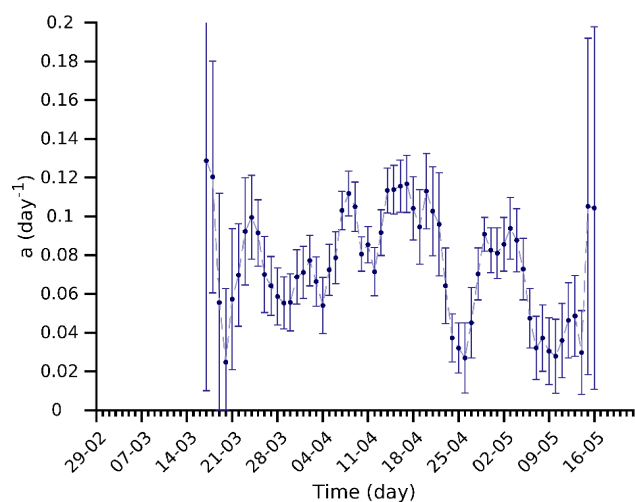
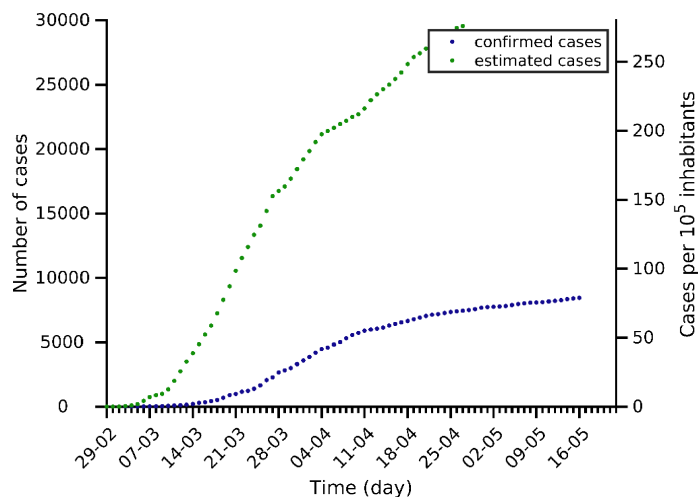
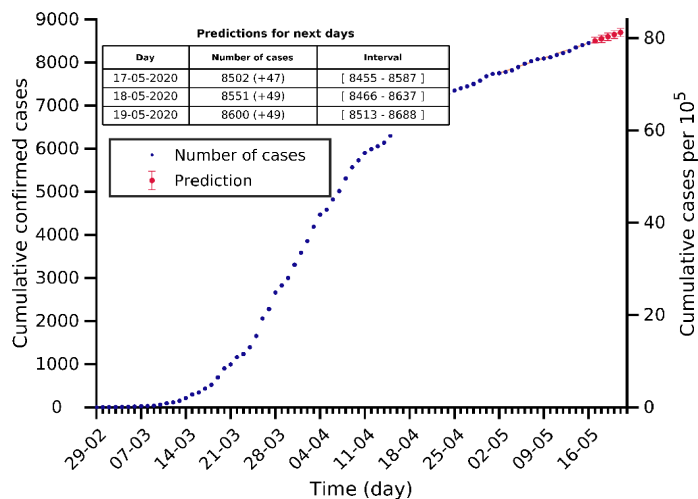
Austria 16-05-2020. Population: 9.0M. Current cumulated incidence: 179/10⁵



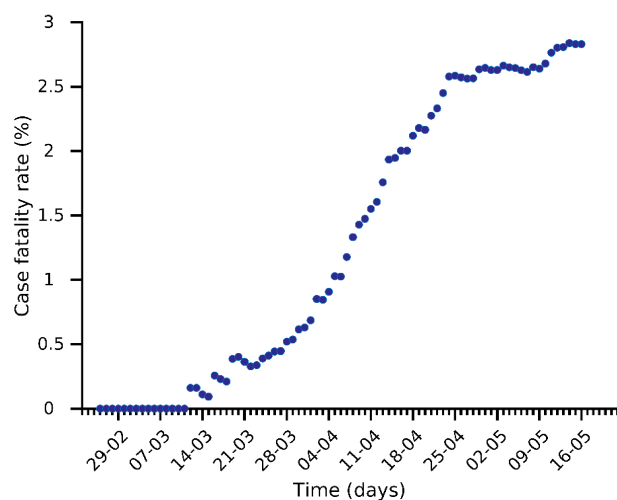
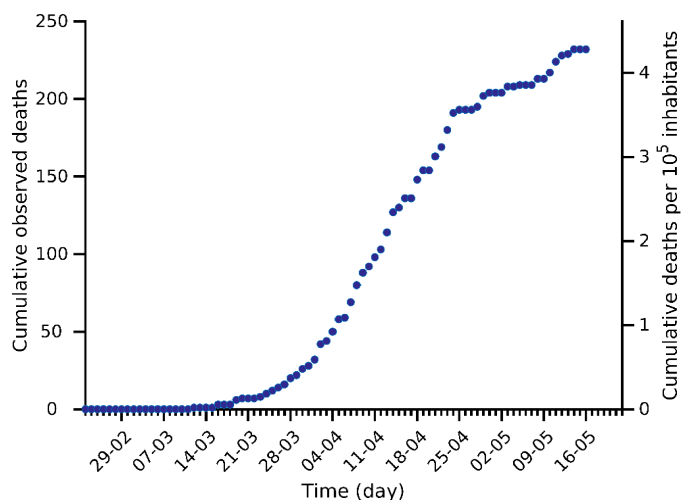
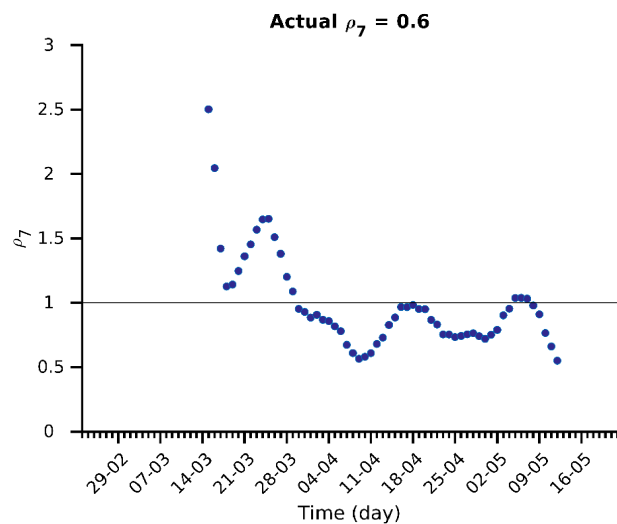
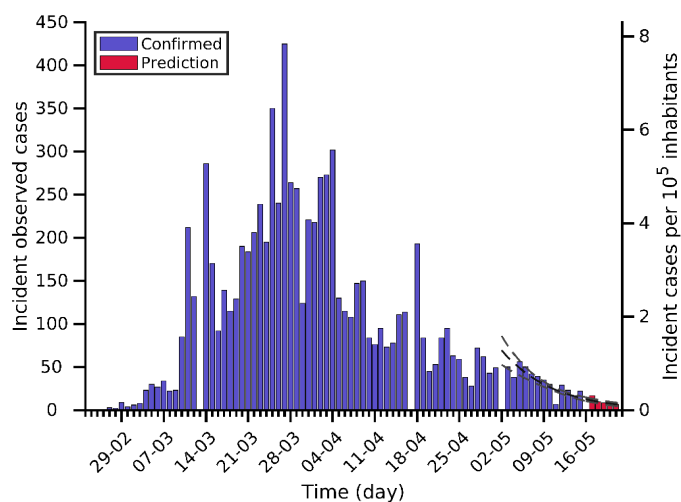
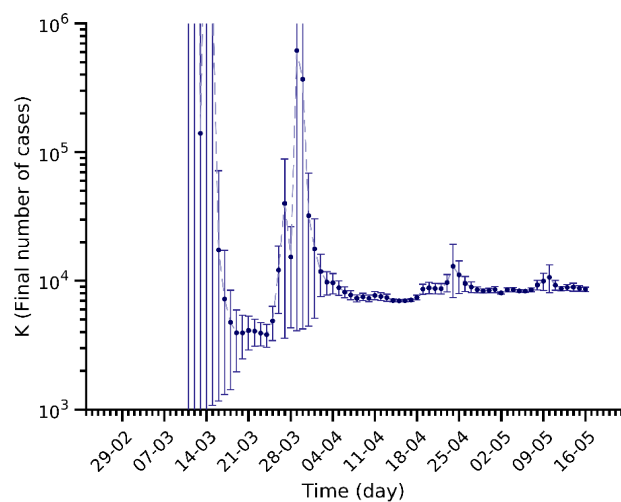
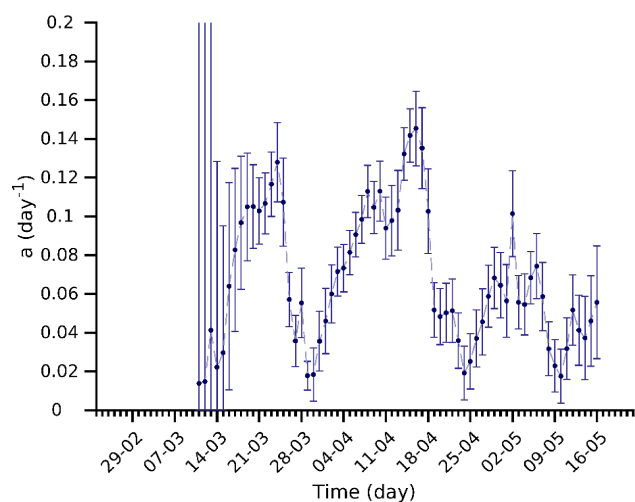
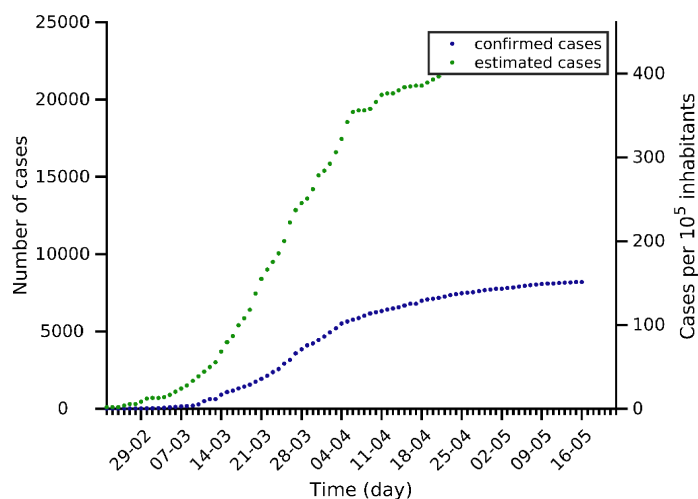
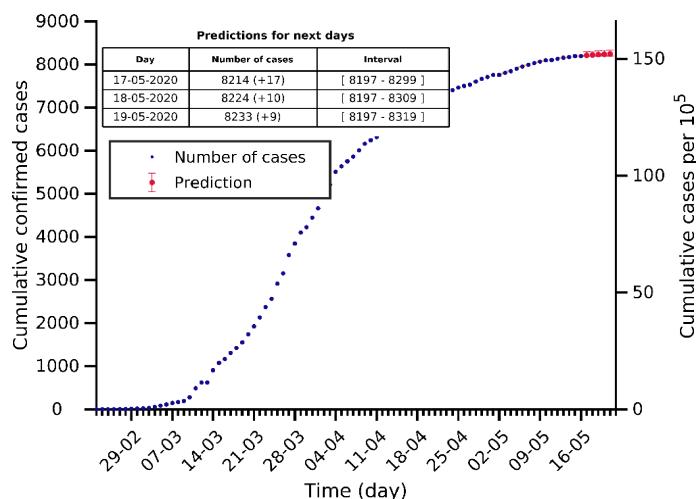
Denmark 16-05-2020. Population: 5.8M. Current cumulated incidence: 187/10⁵



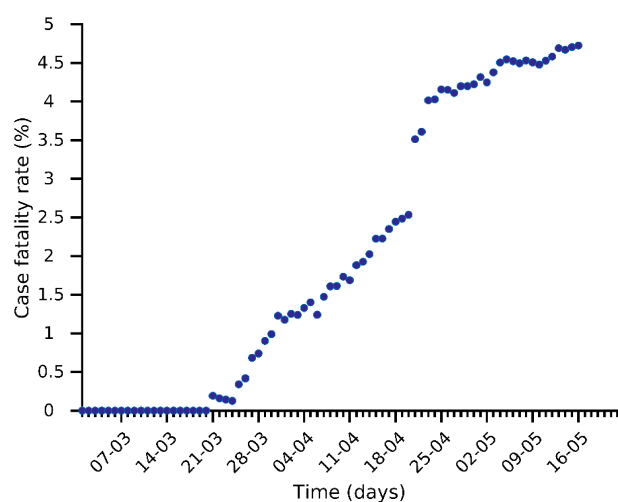
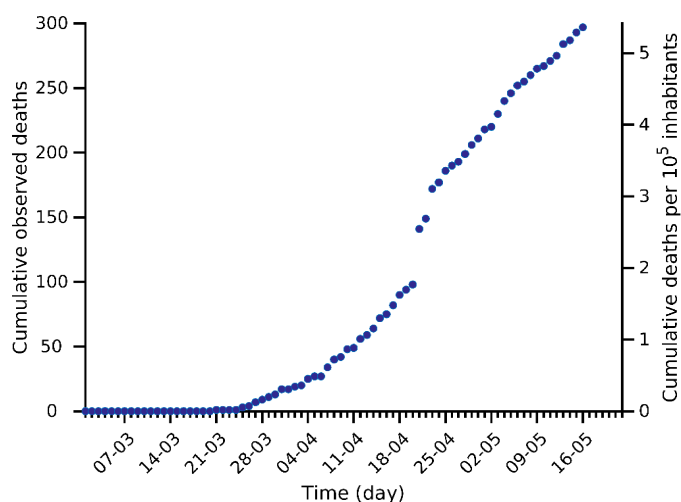
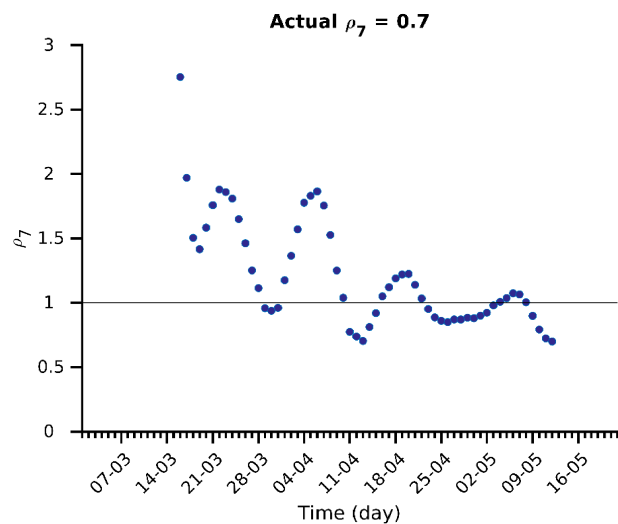
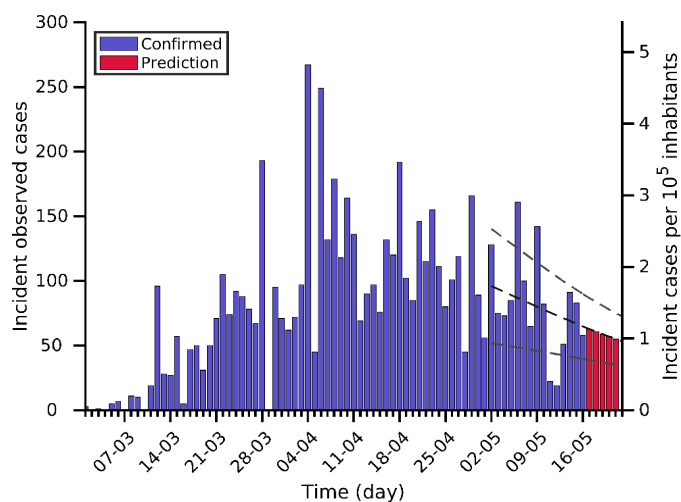
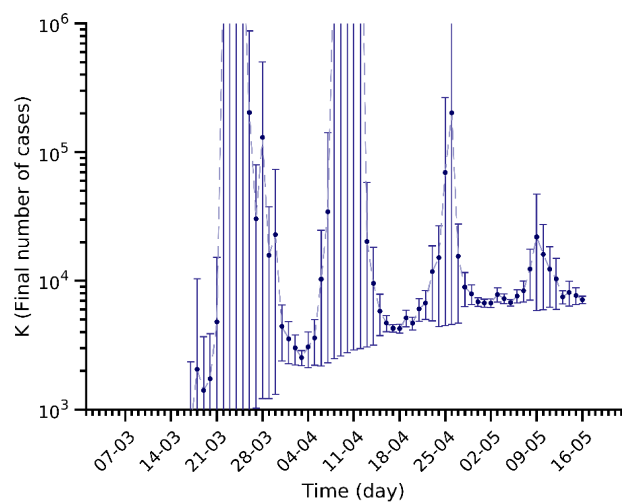
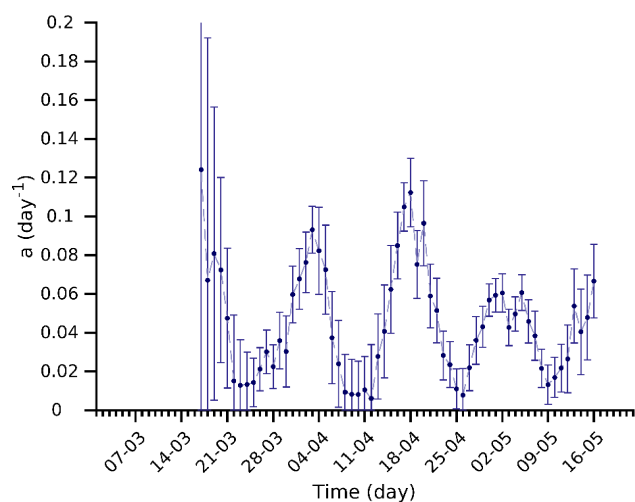
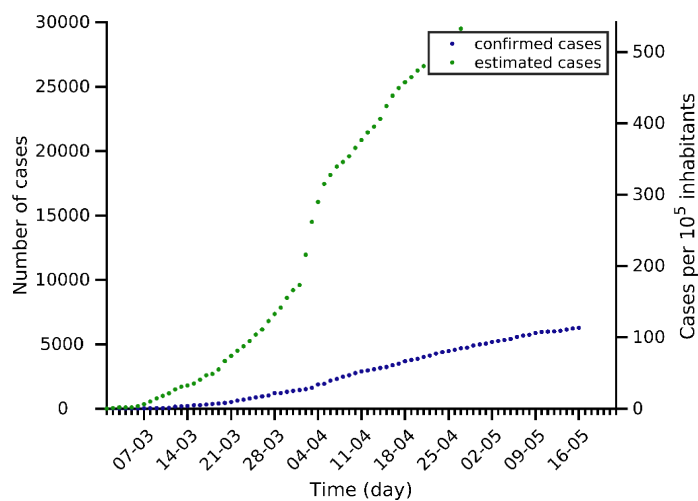
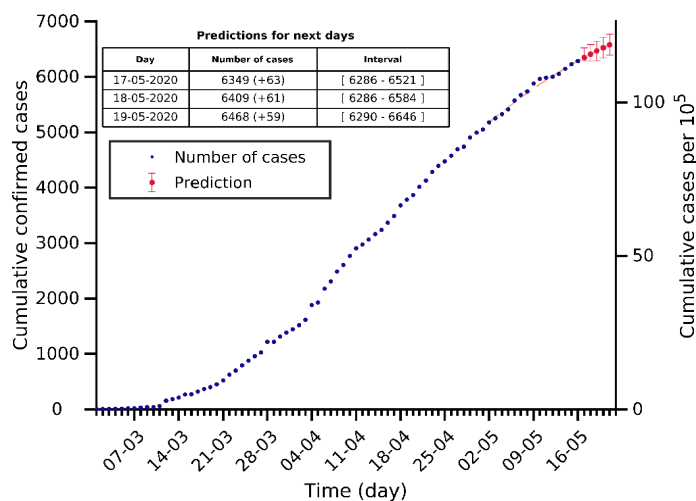
Czech Rep 16-05-2020. Population: 10.7M. Current cumulated incidence: 79/10⁵



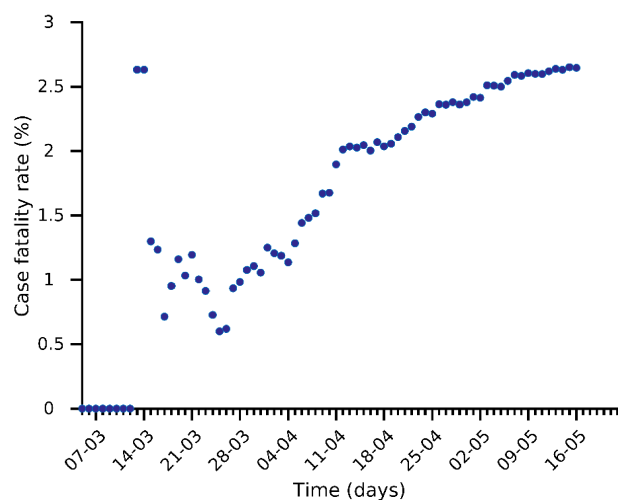
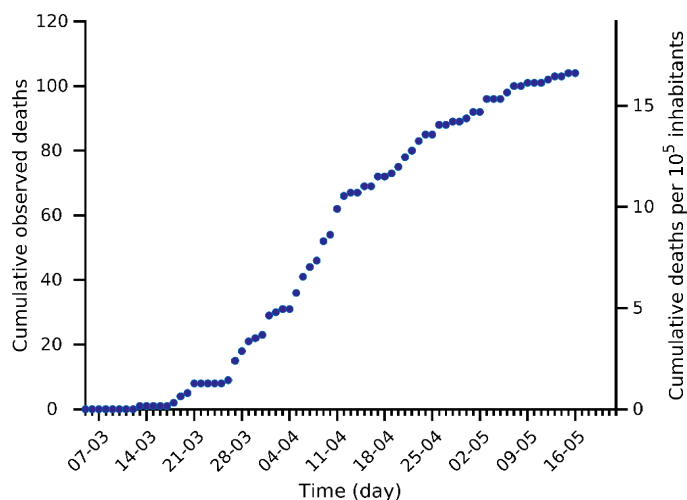
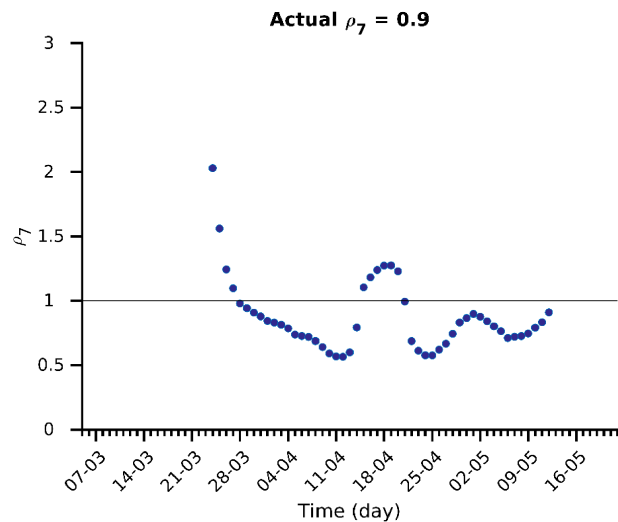
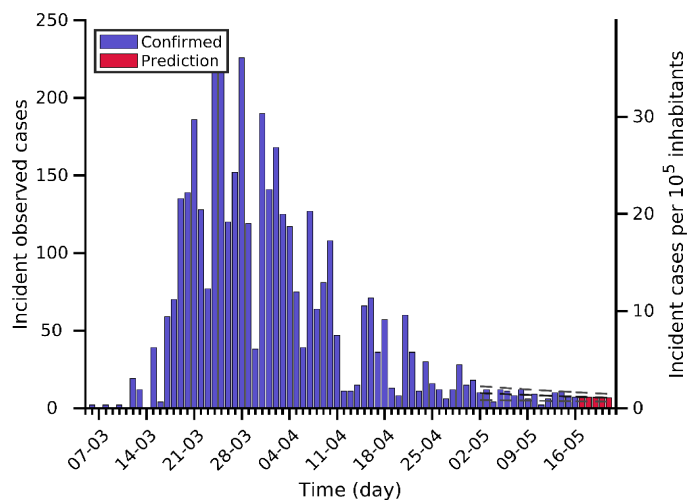
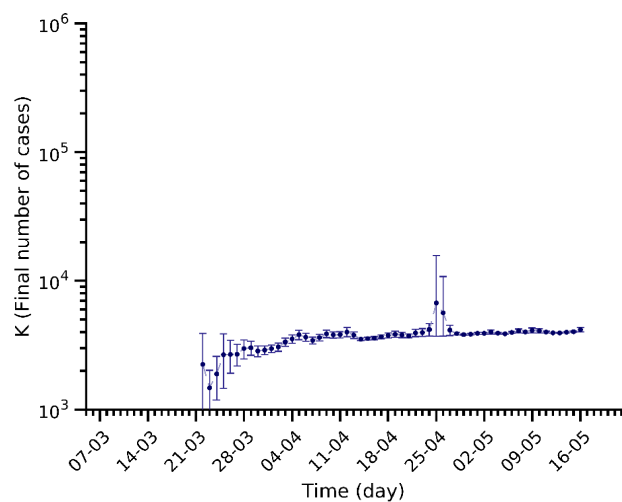
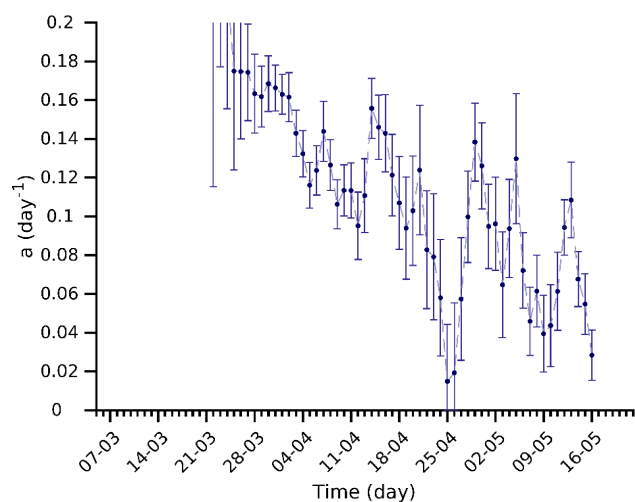
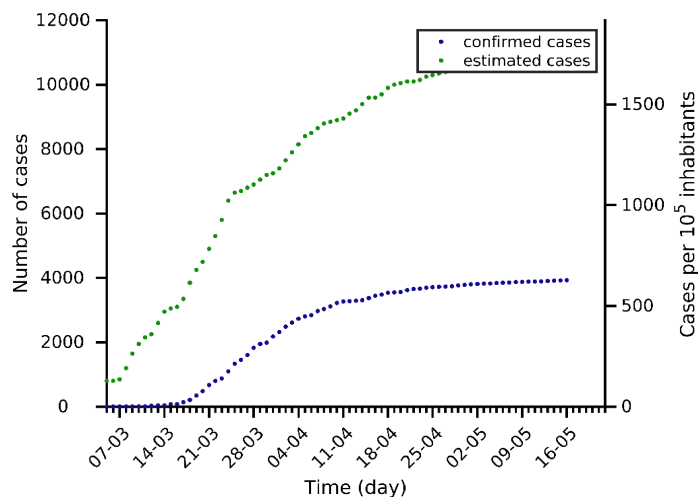
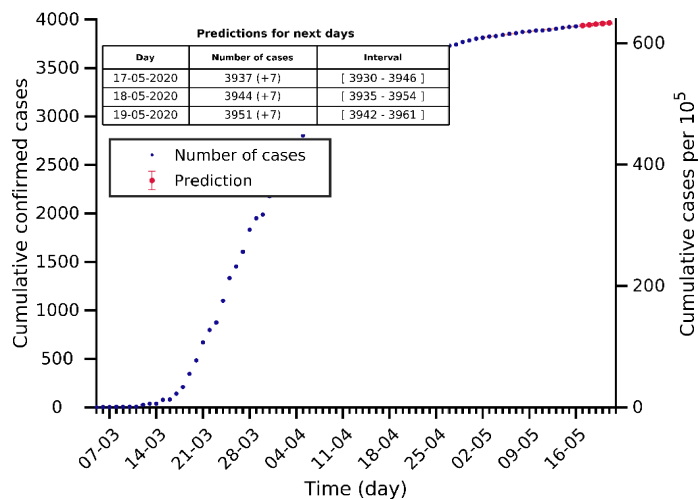
Norway 16-05-2020. Population: 5.4M. Current cumulated incidence: 151/10⁵



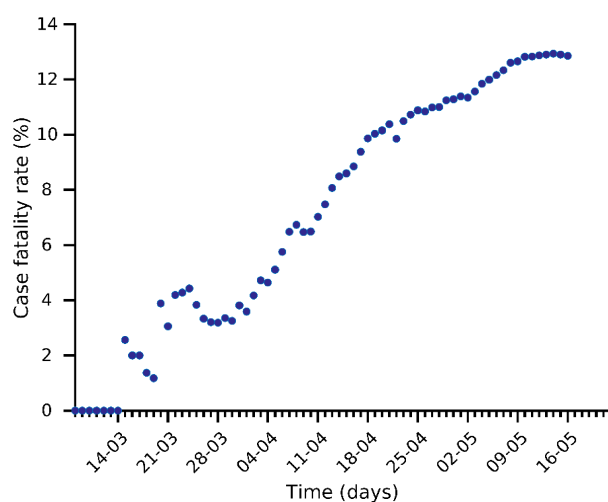
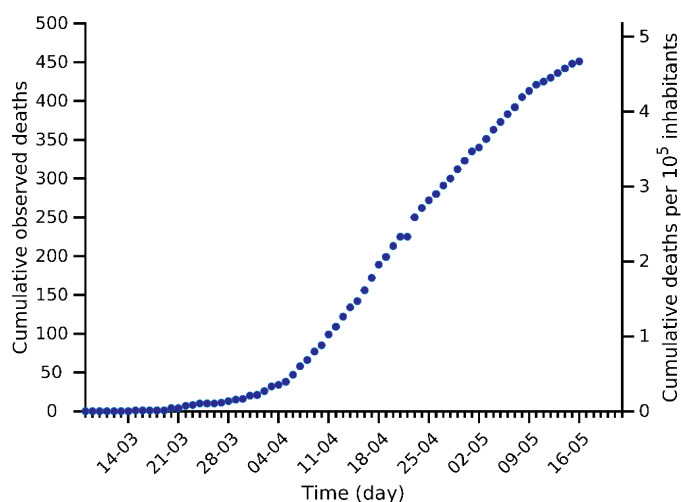
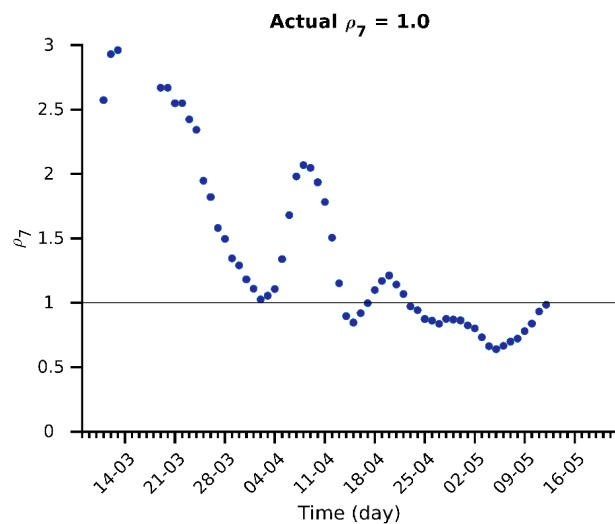
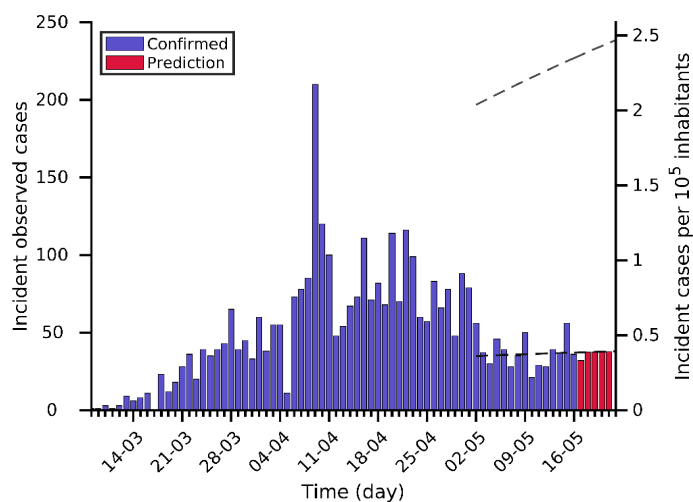
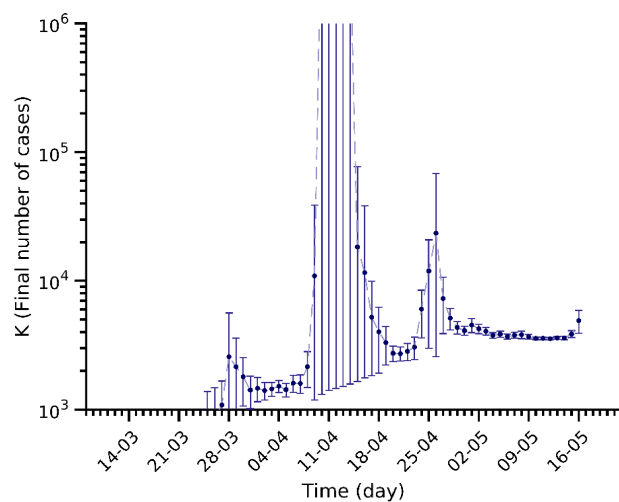
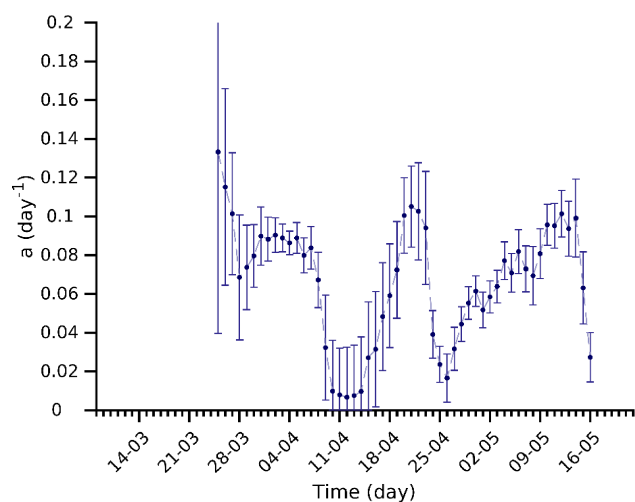
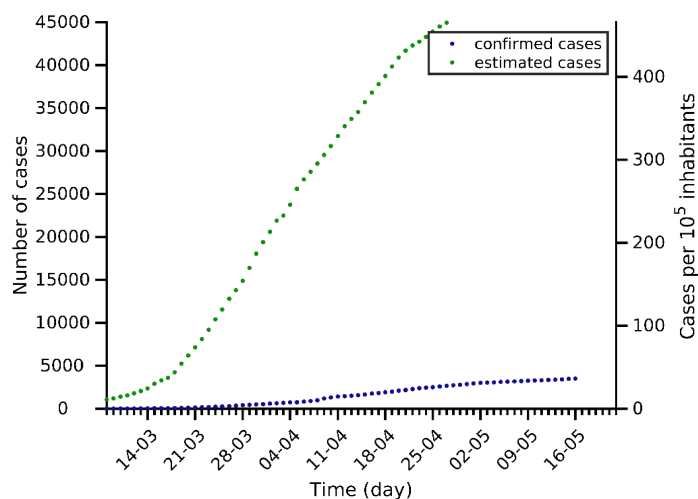
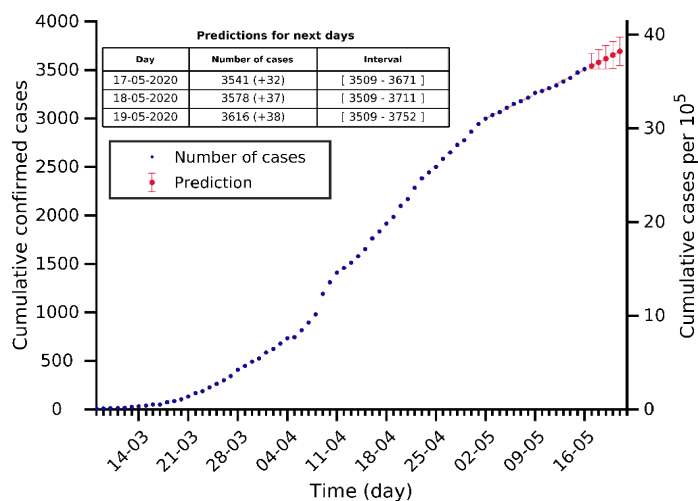
Finland 16-05-2020. Population: 5.5M. Current cumulated incidence: 113/10⁵



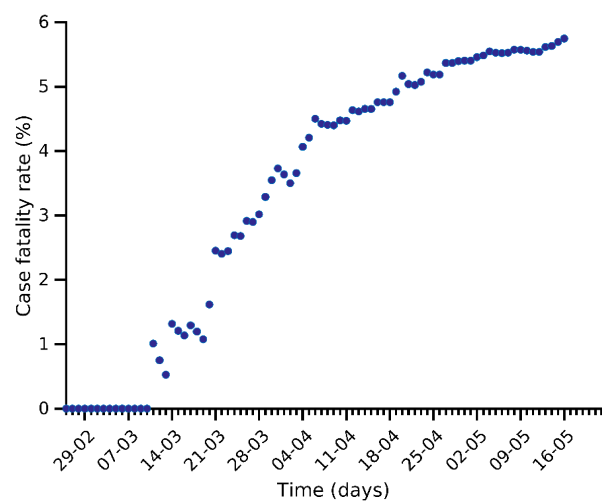
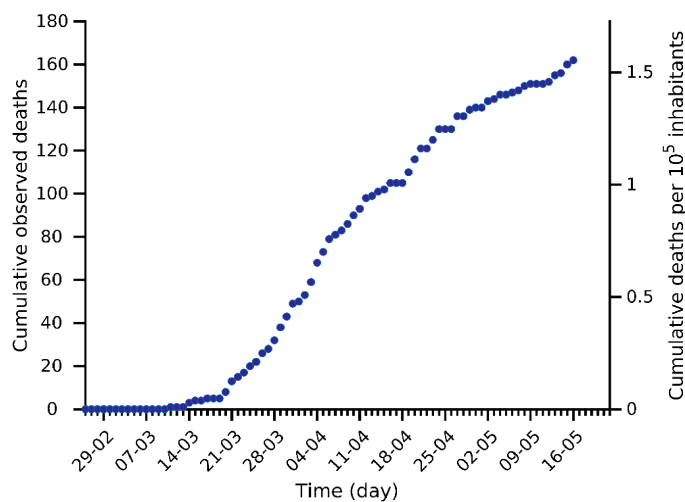
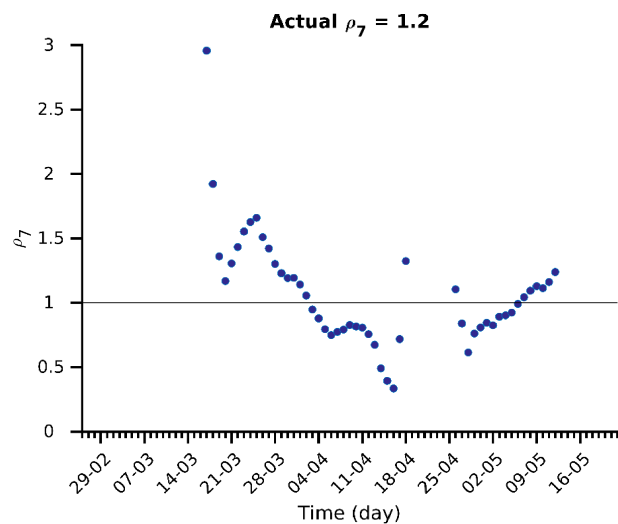
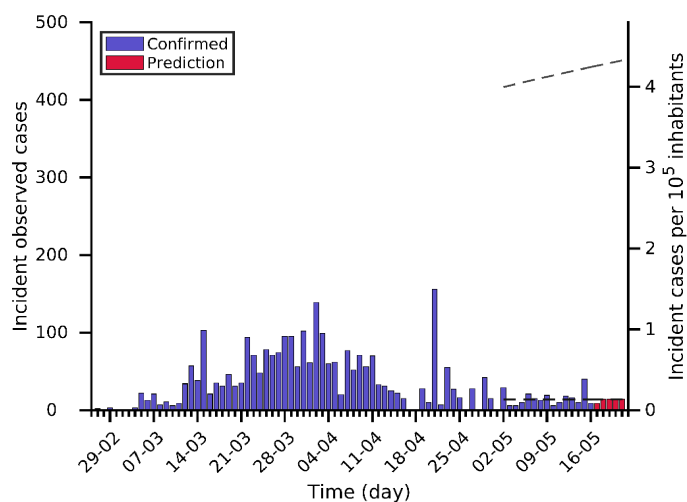
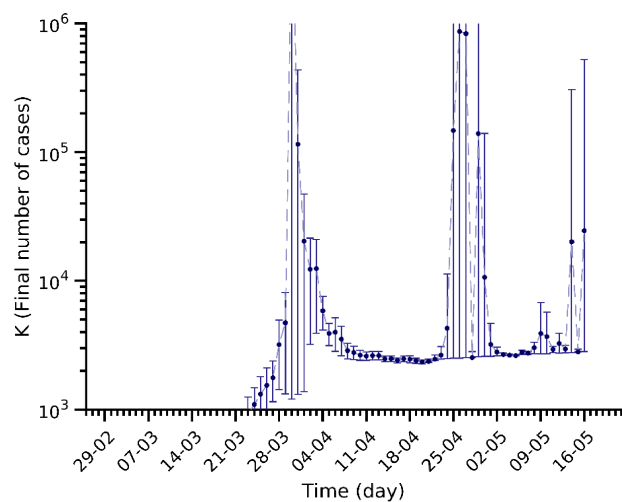
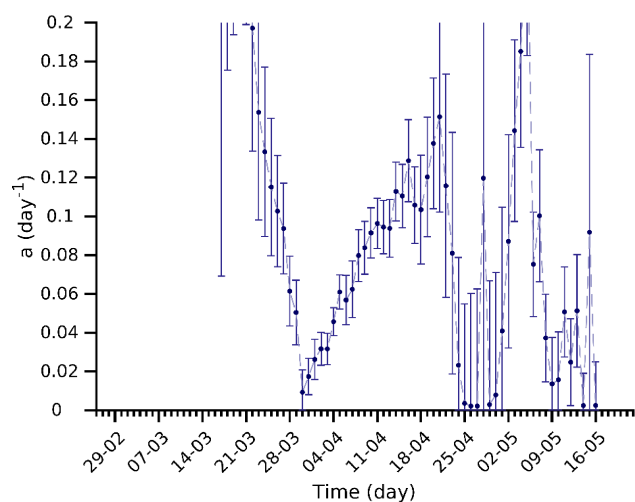
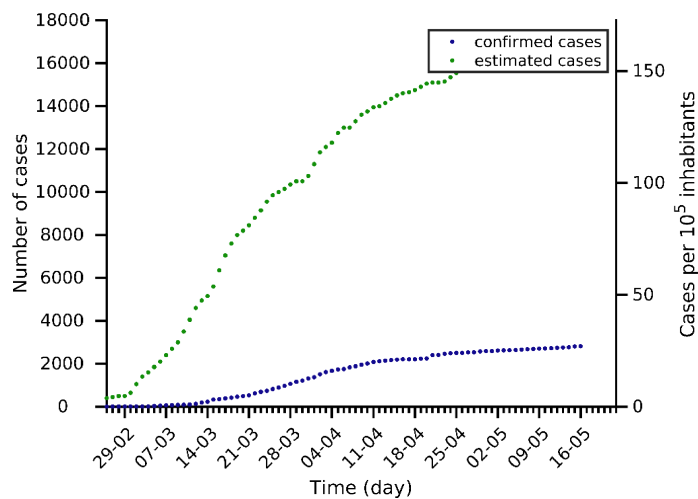
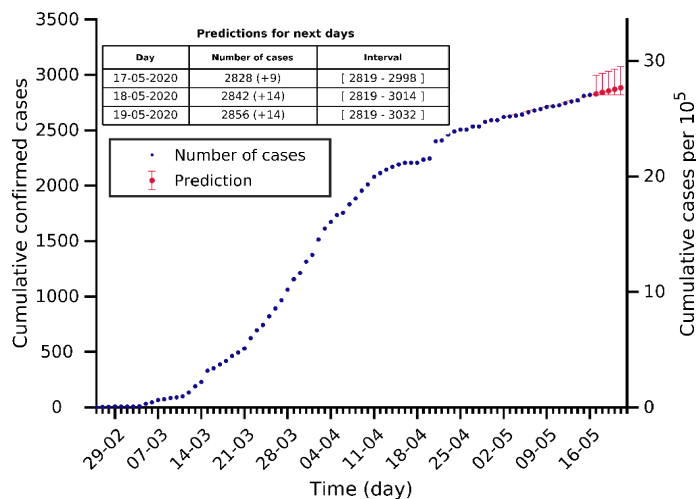
Luxembourg 16-05-2020. Population: 0.6M. Current cumulated incidence: 628/10⁵



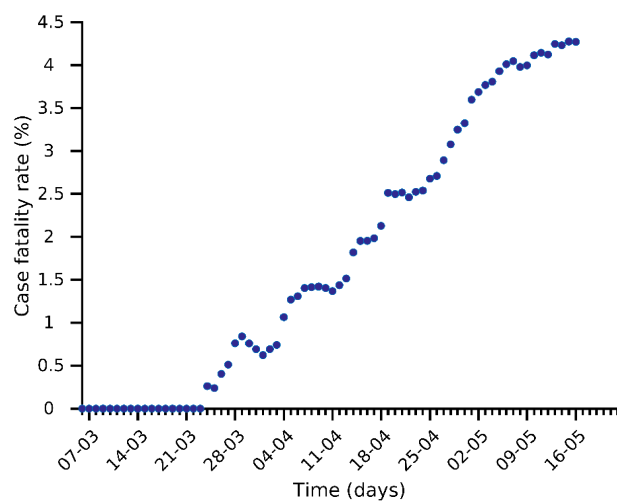
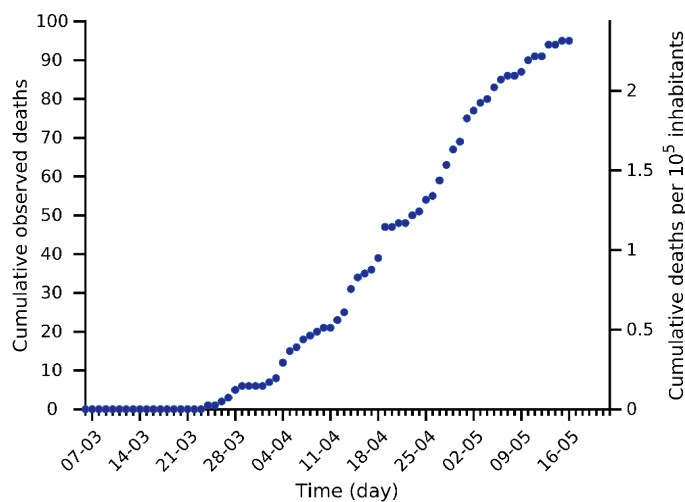
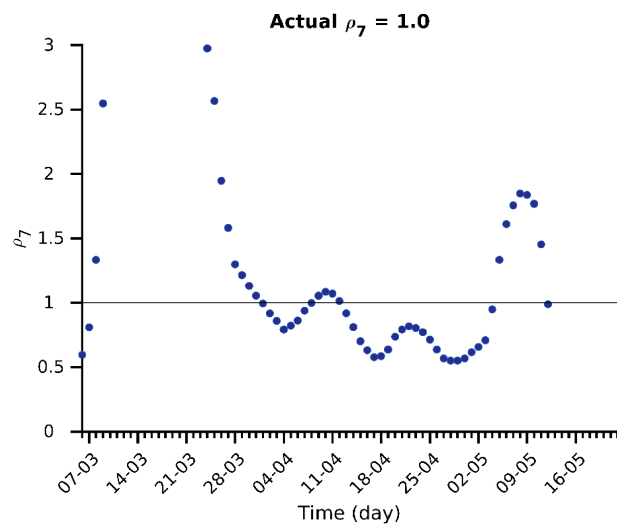
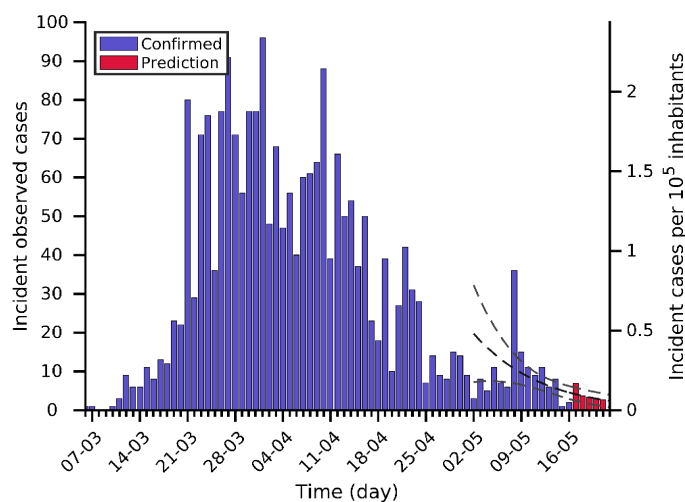
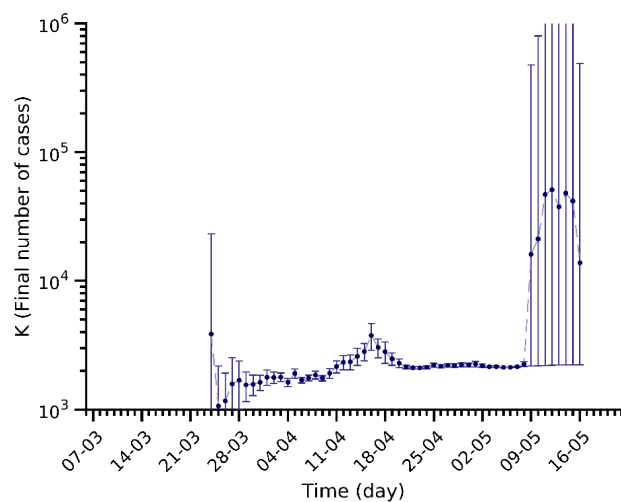
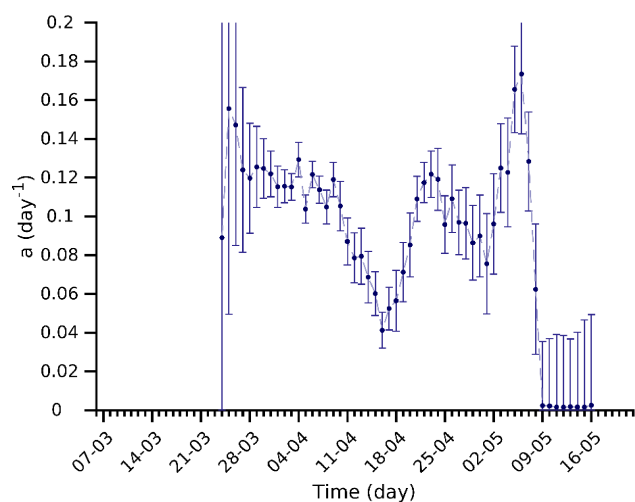
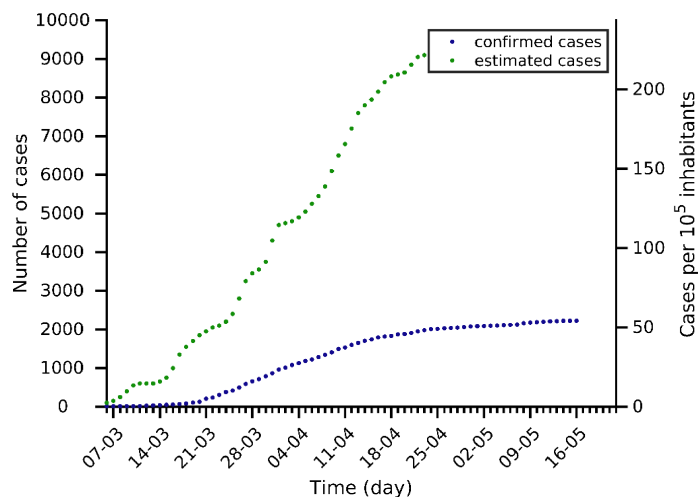
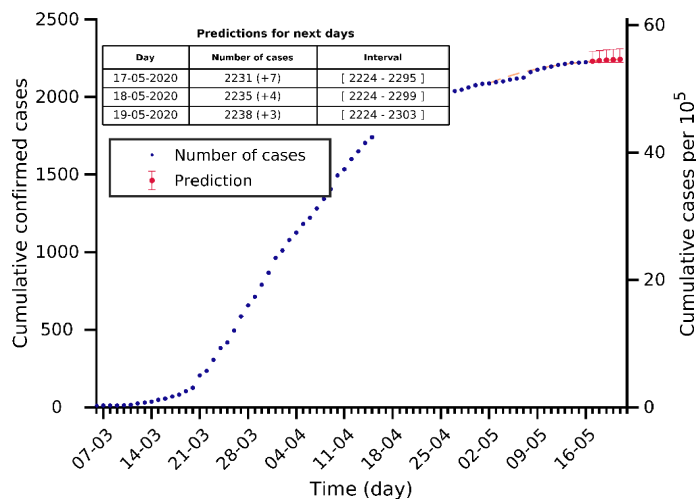
Hungary 16-05-2020. Population: 9.7M. Current cumulated incidence: 36/10⁵



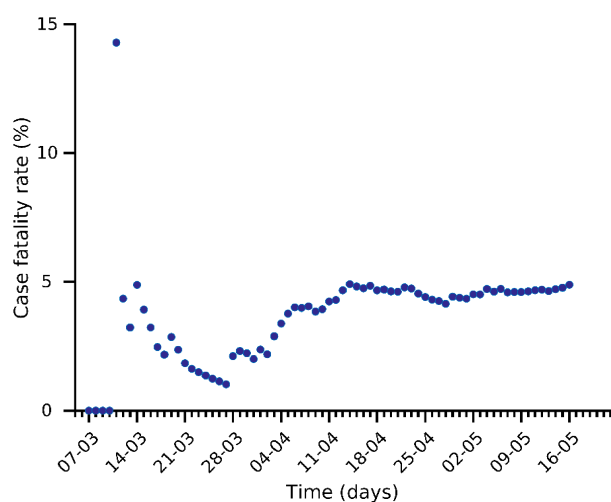
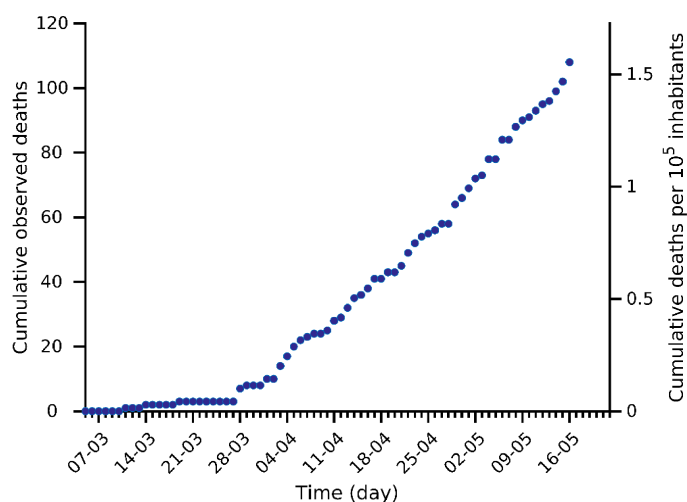
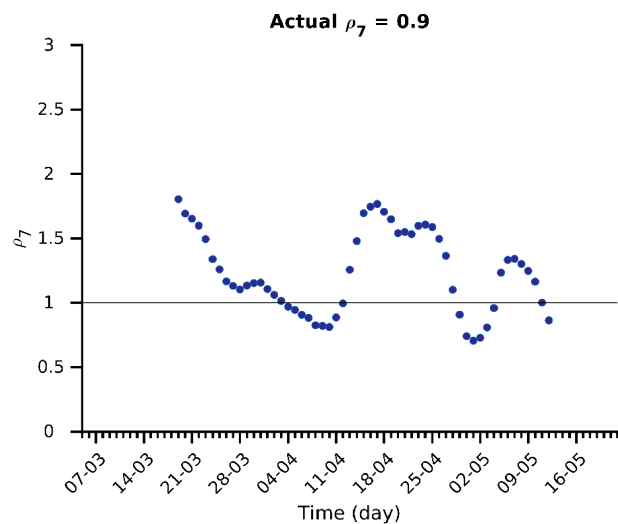
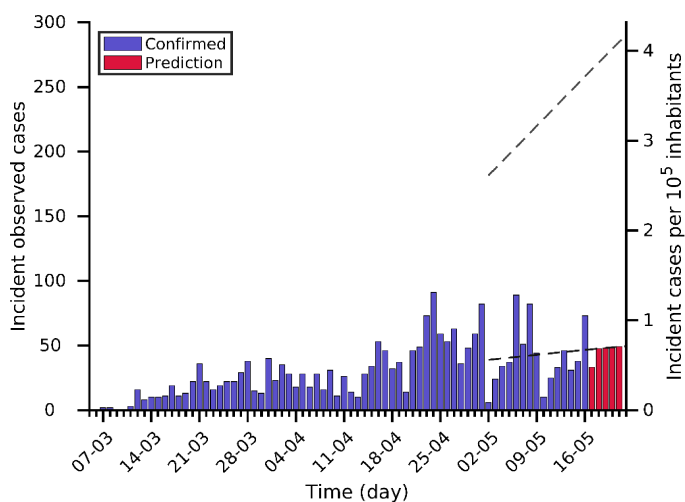
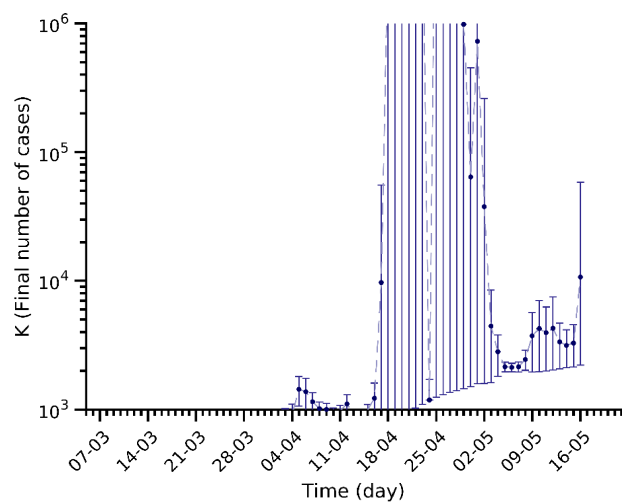
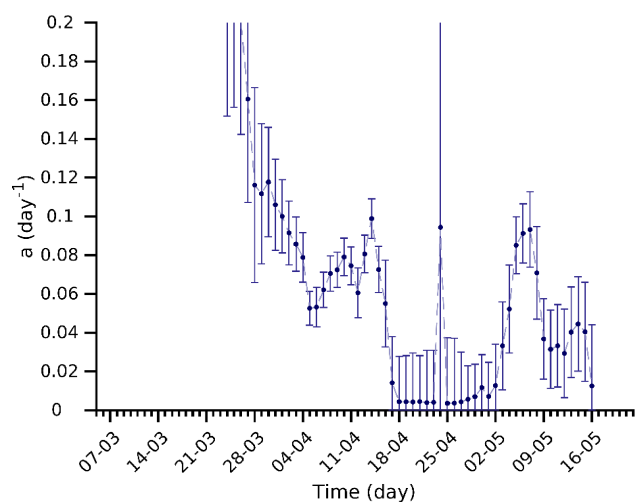
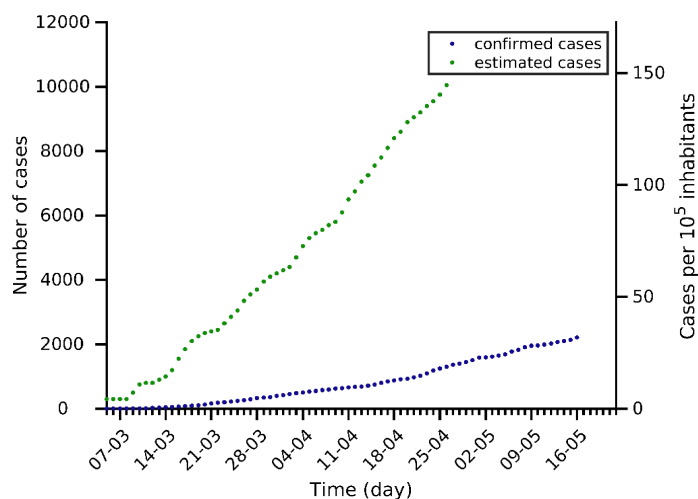
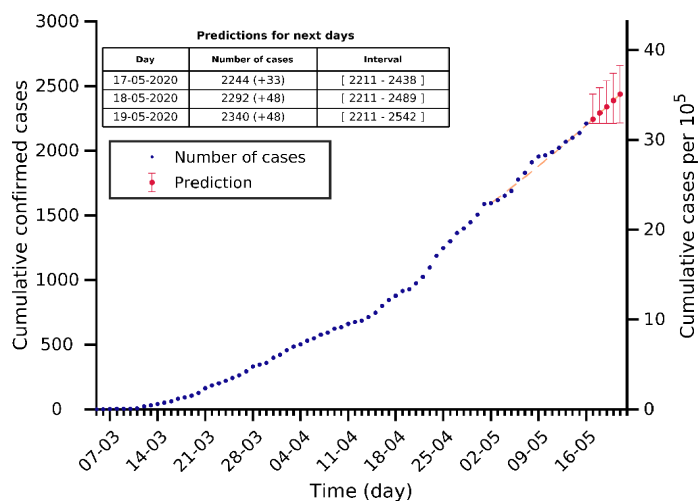
Greece 16-05-2020. Population: 10.4M. Current cumulated incidence: 27/10⁵



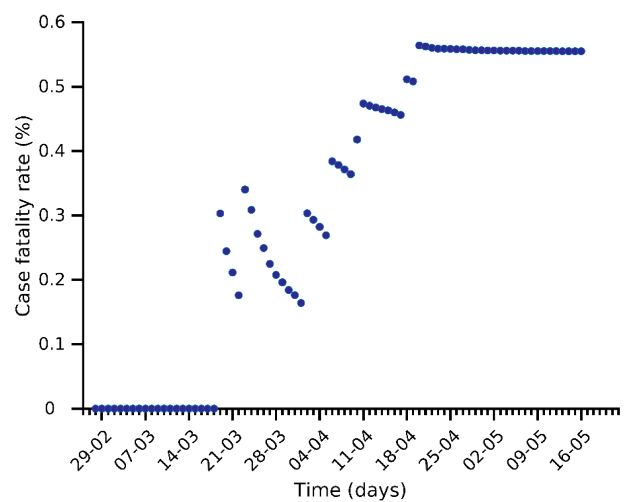
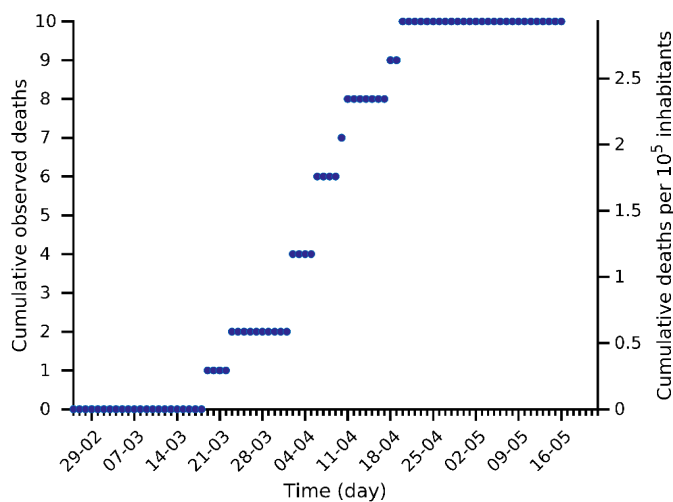
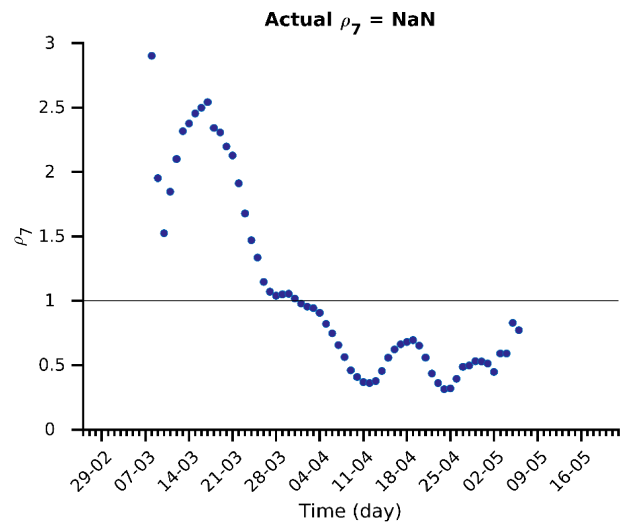
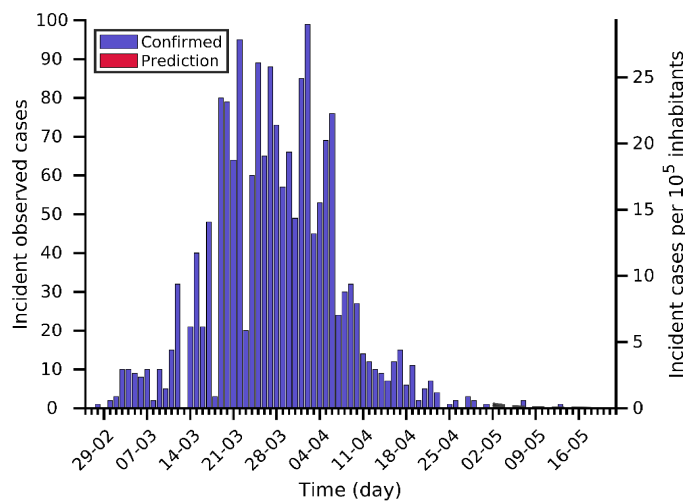
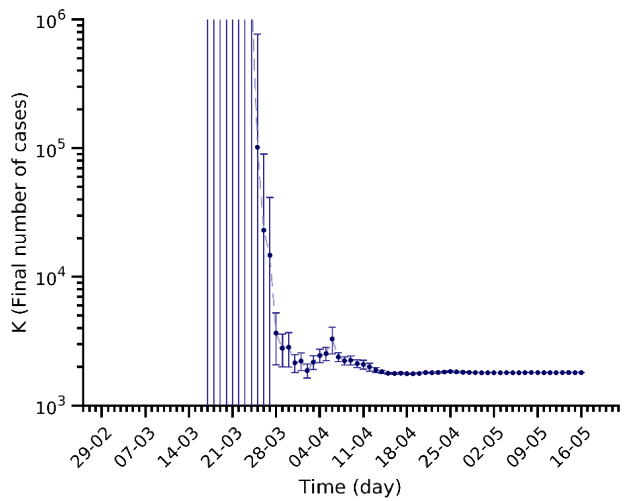
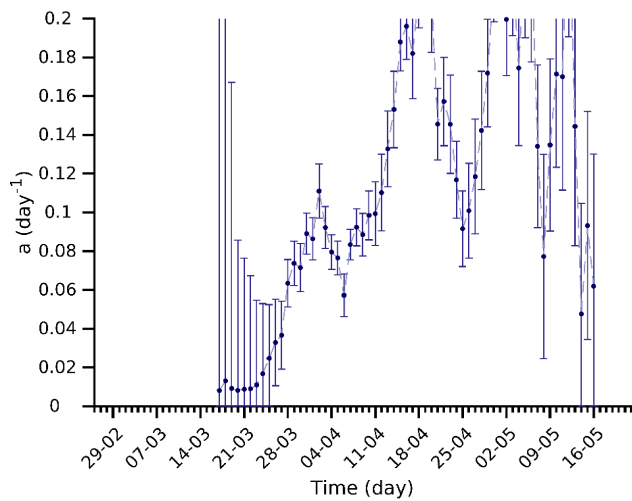
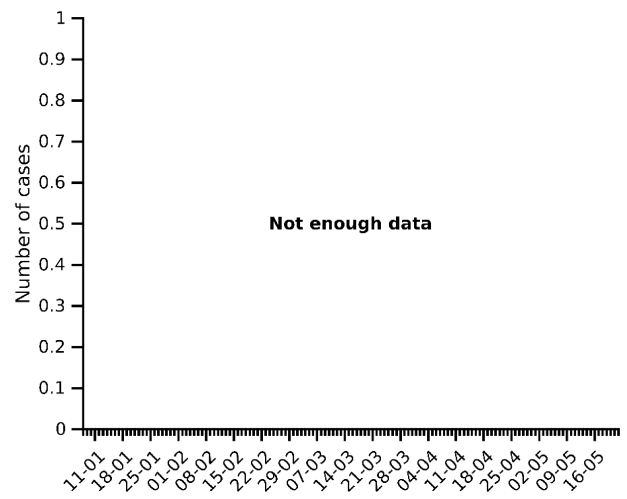
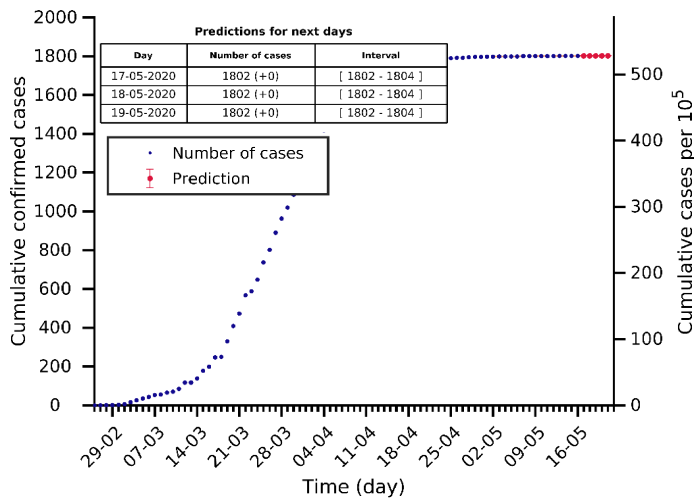
Croatia 16-05-2020. Population: 4.1M. Current cumulated incidence: 54/10⁵



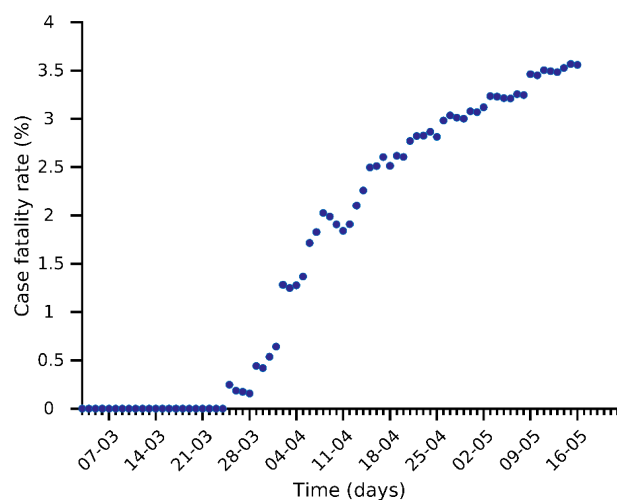
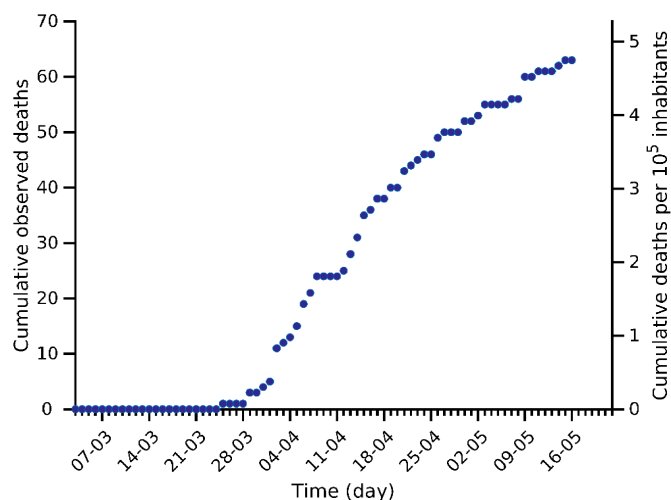
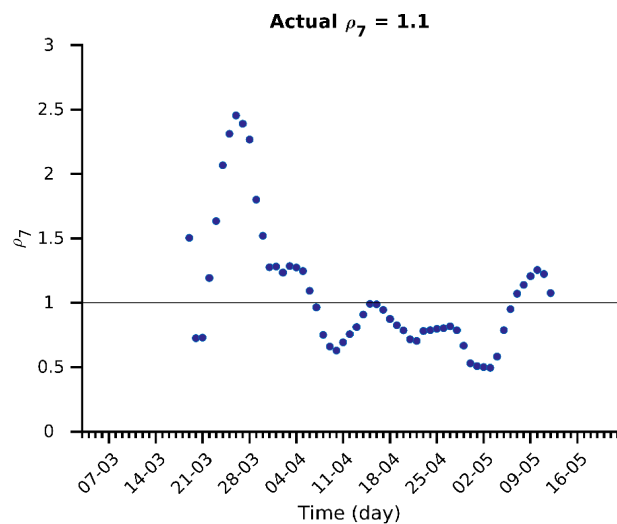
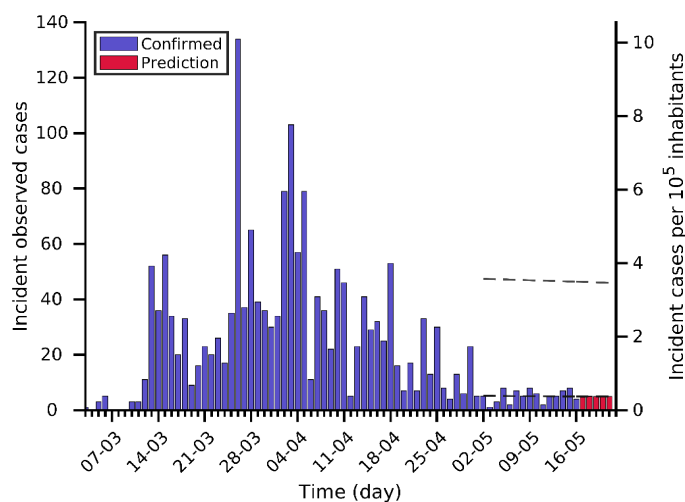
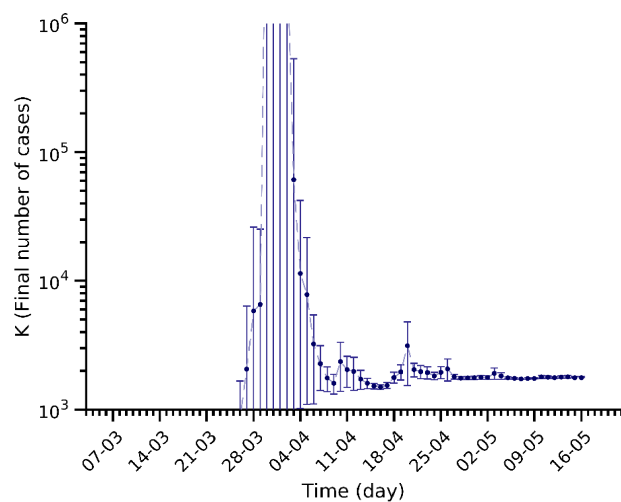
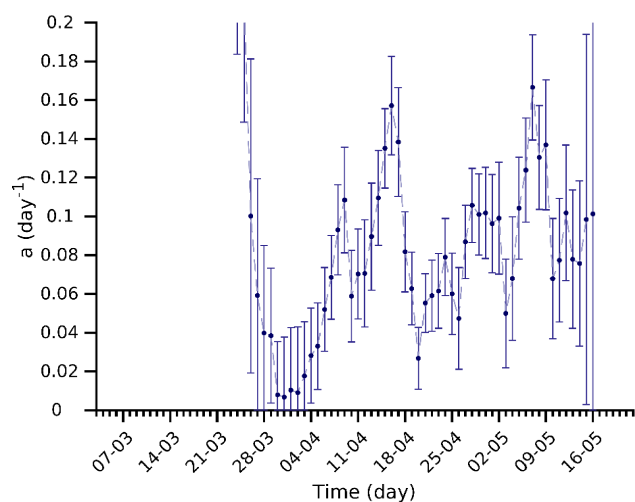
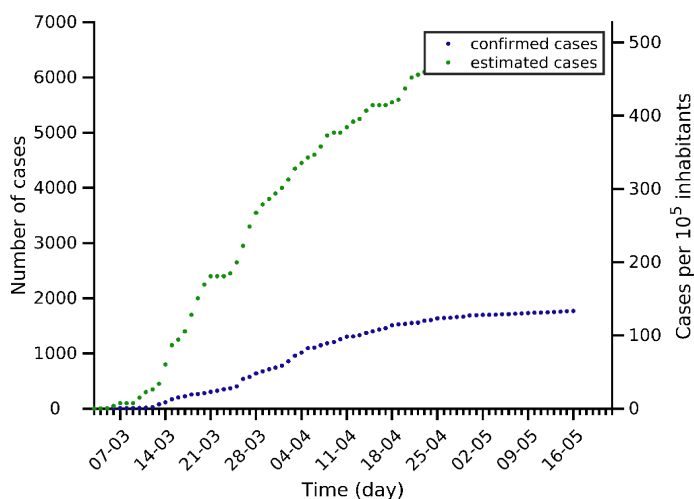
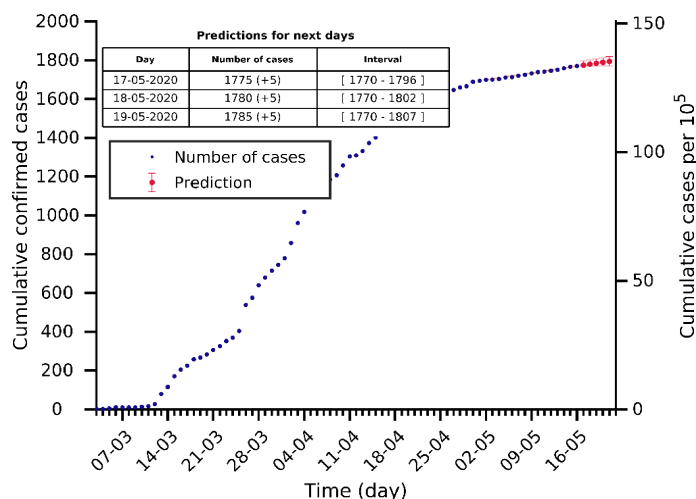
Bulgaria 16-05-2020. Population: 6.9M. Current cumulated incidence: 32/10⁵



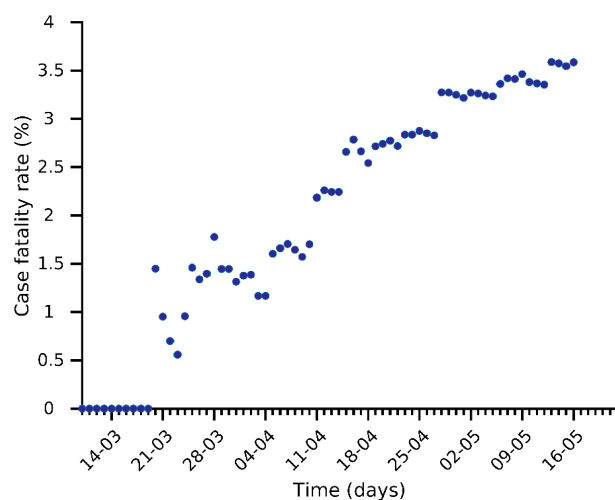
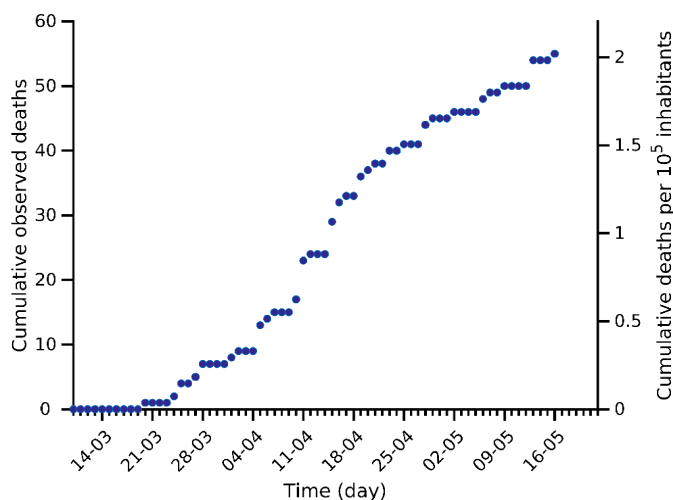
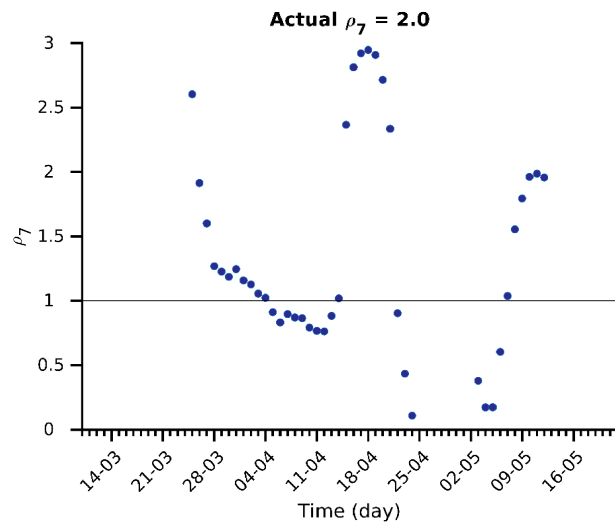
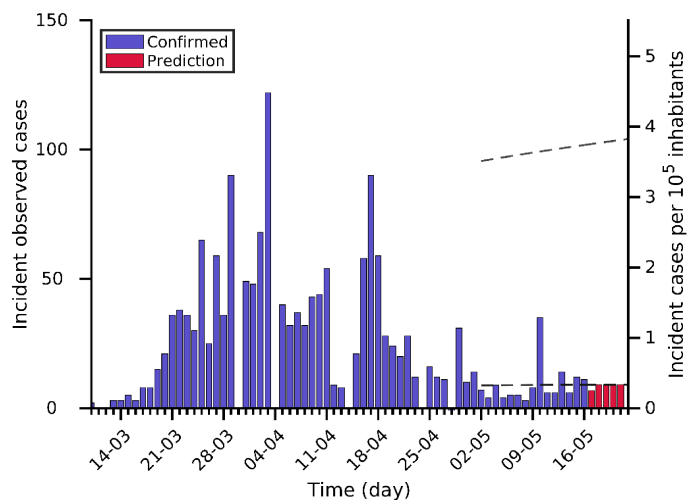
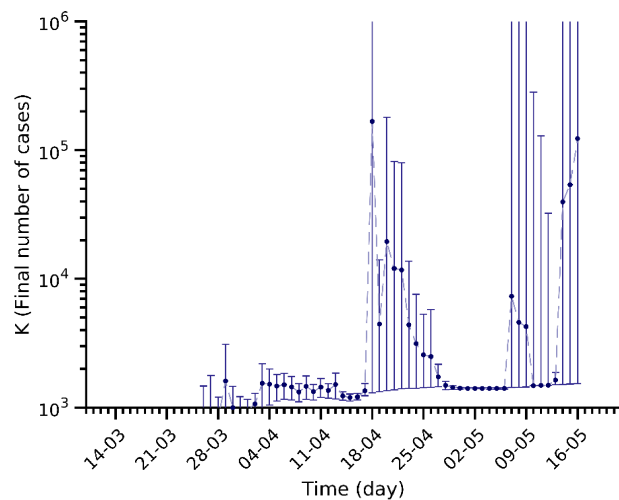
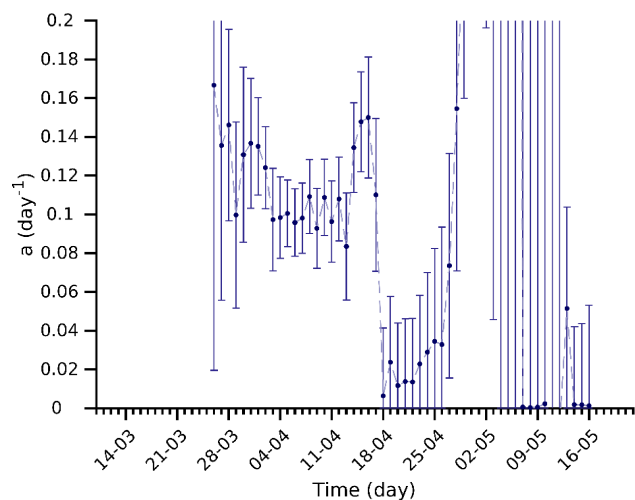
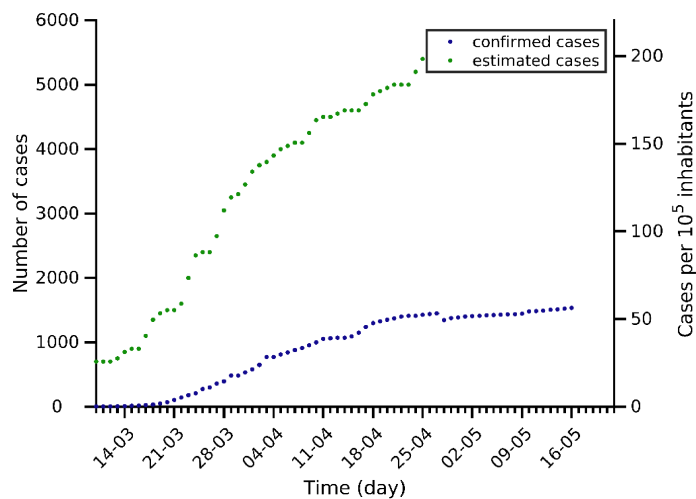
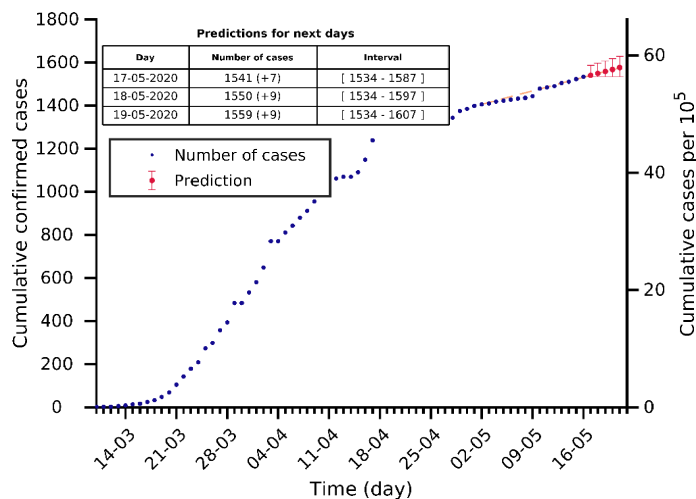
Iceland 16-05-2020. Population: 0.3M. Current cumulated incidence: 528/10⁵



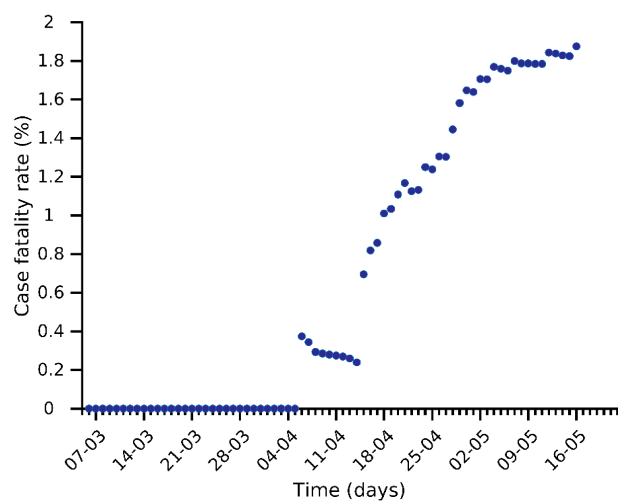
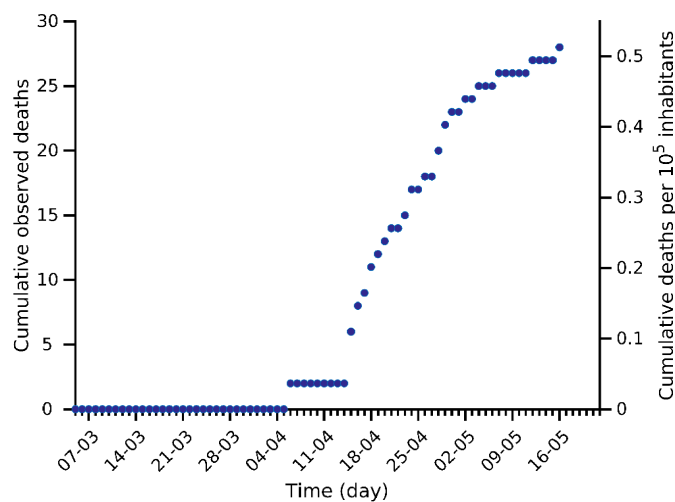
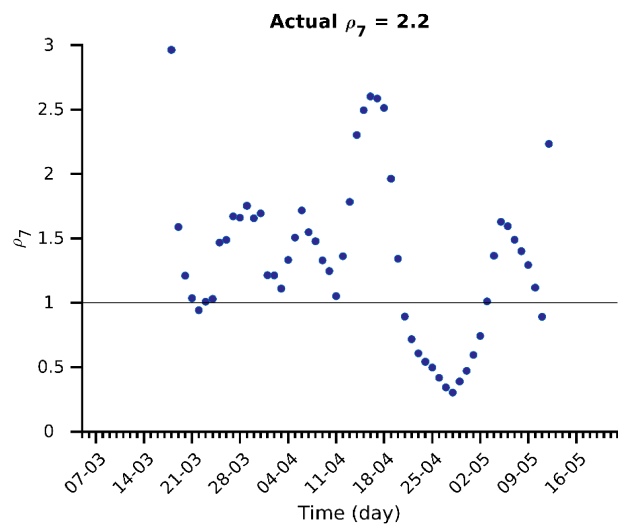
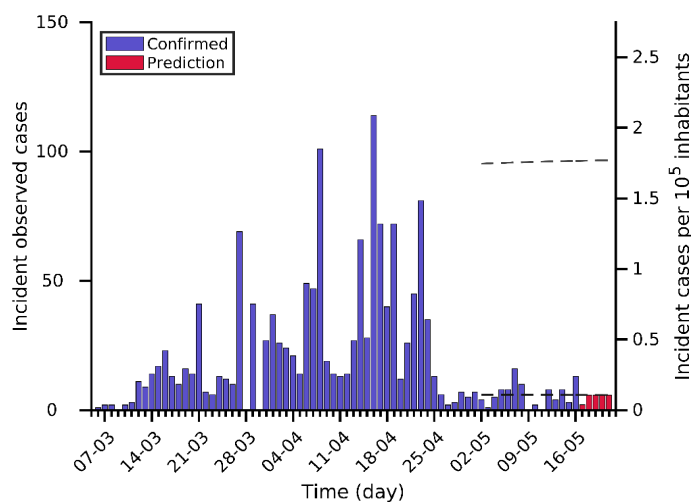
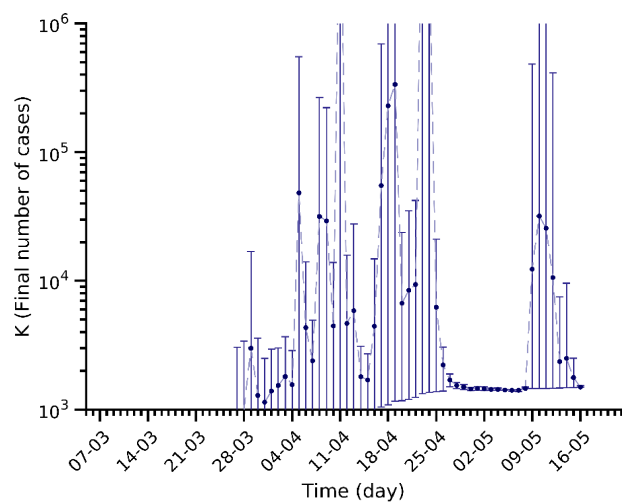
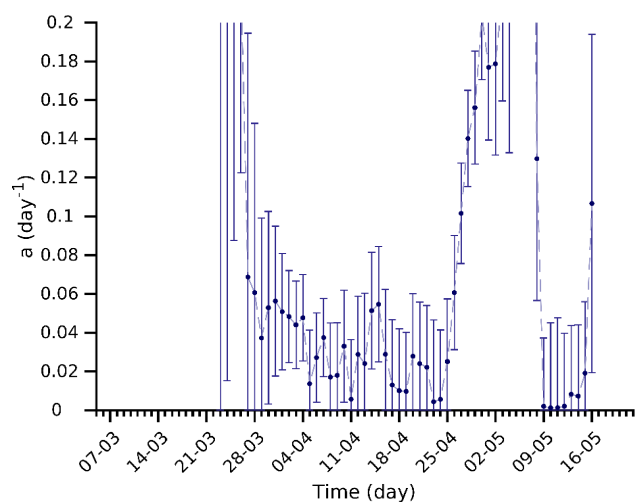
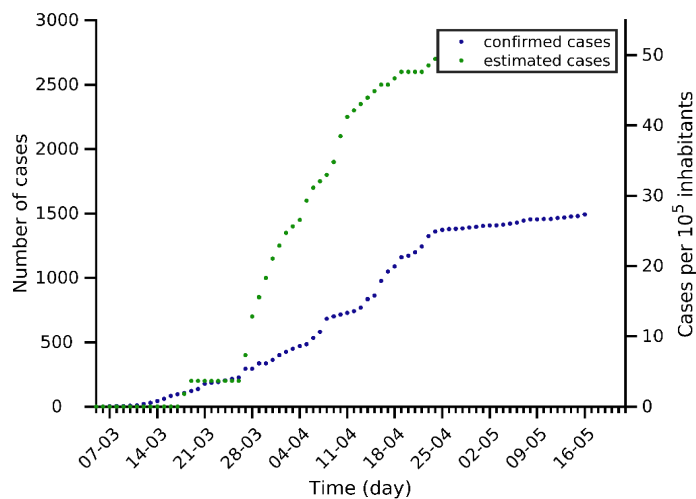
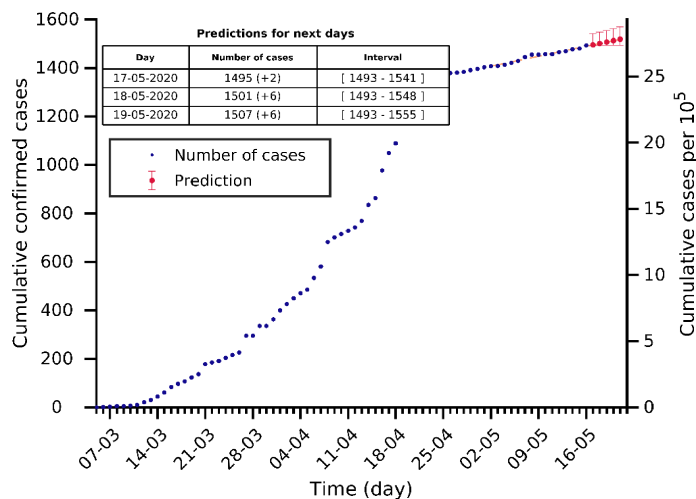
Estonia 16-05-2020. Population: 1.3M. Current cumulated incidence: 133/10⁵



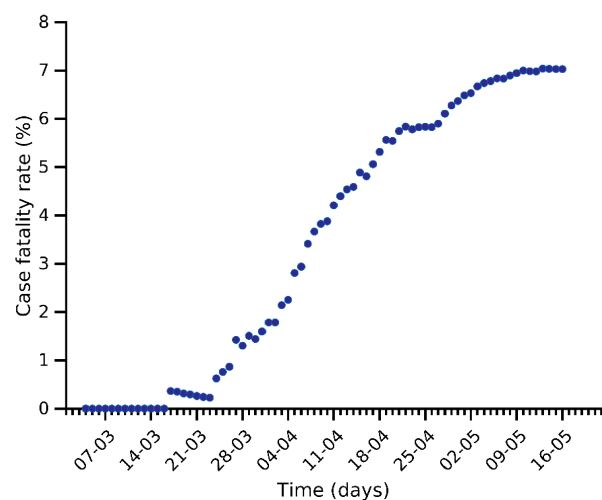
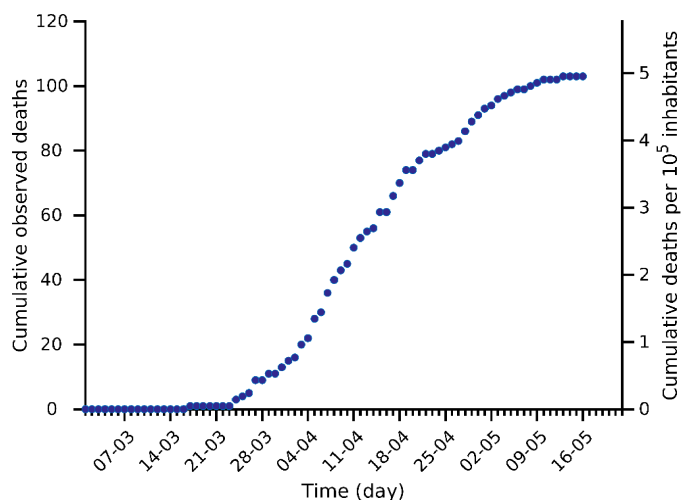
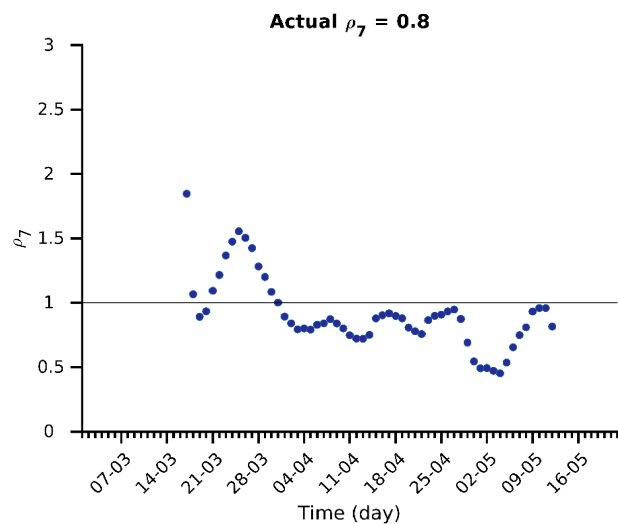
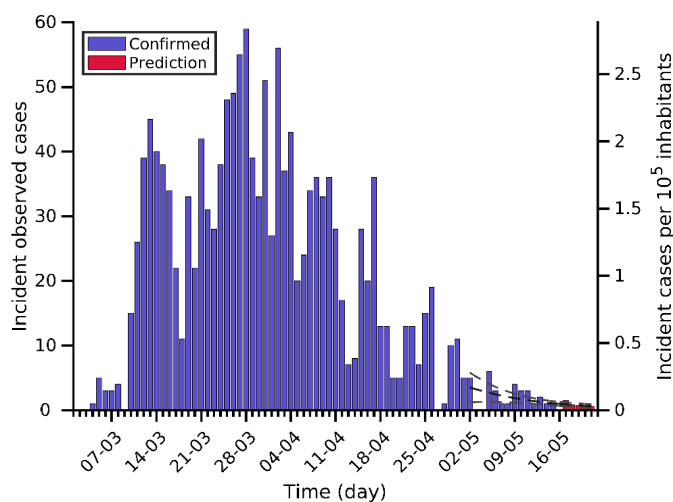
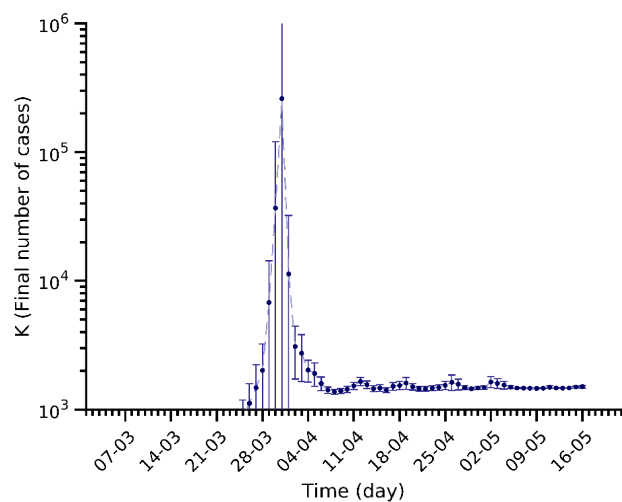
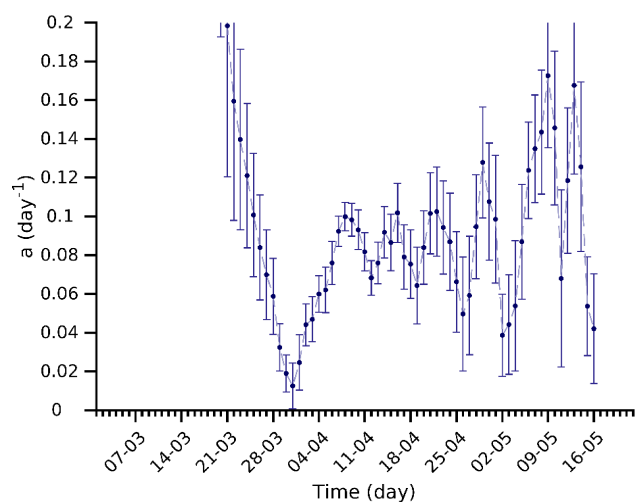
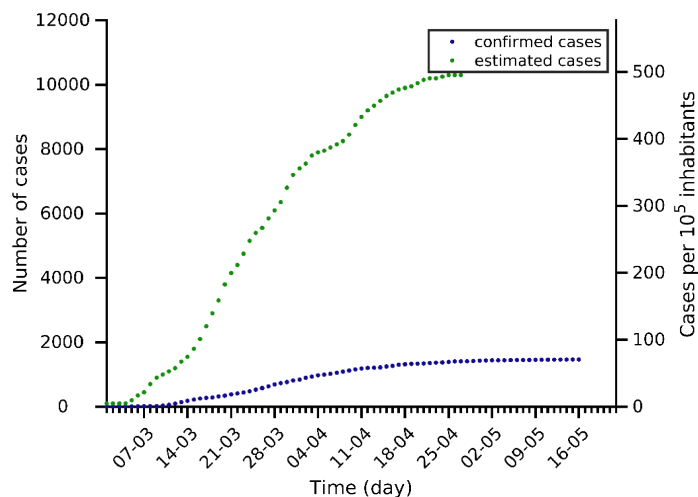
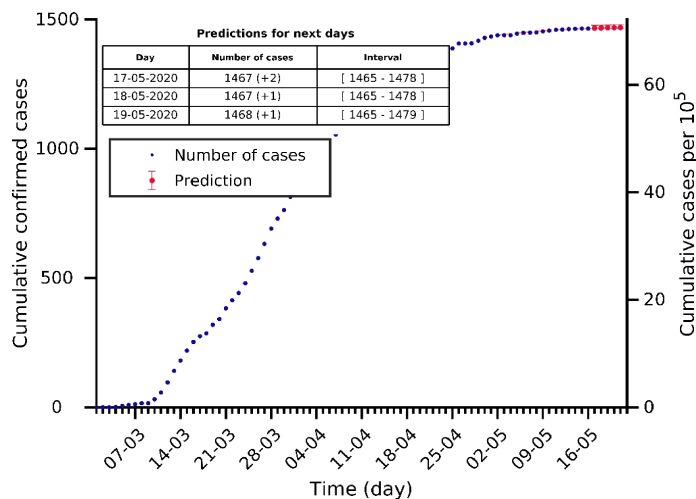
Lithuania 16-05-2020. Population: 2.7M. Current cumulated incidence: 56/10⁵



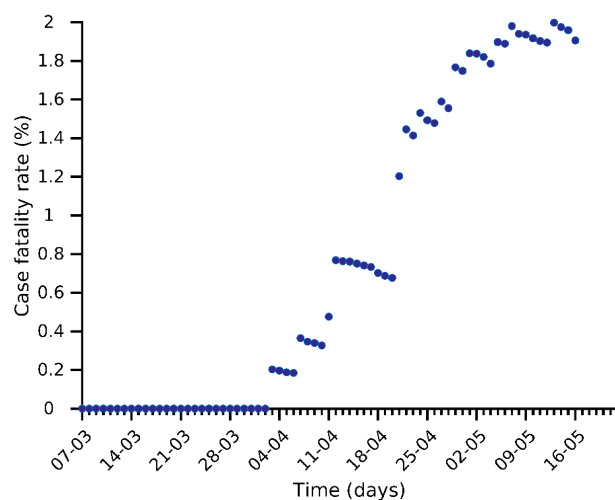
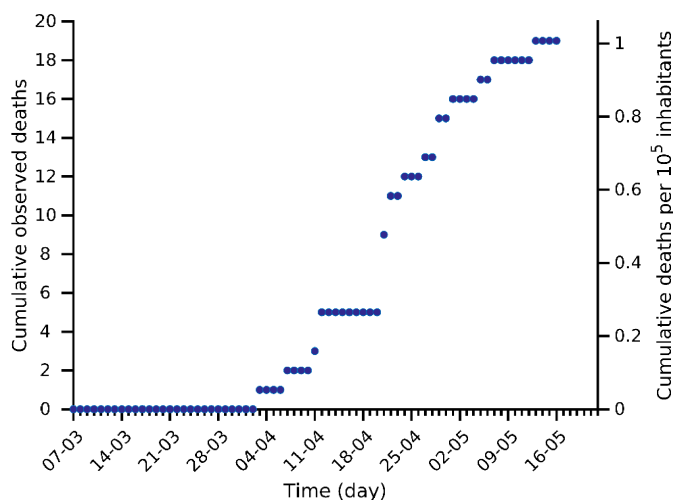
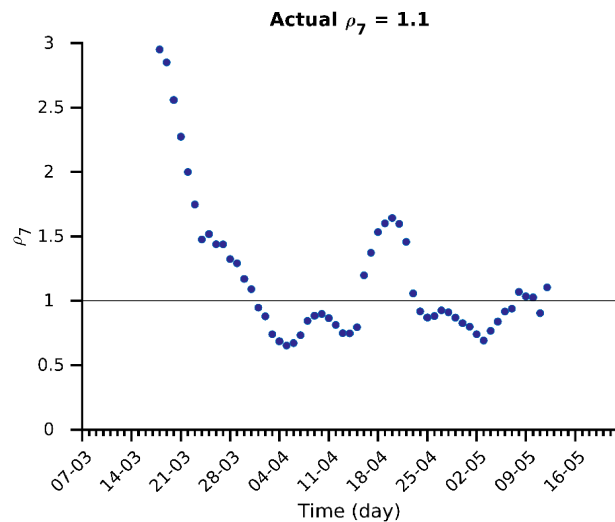
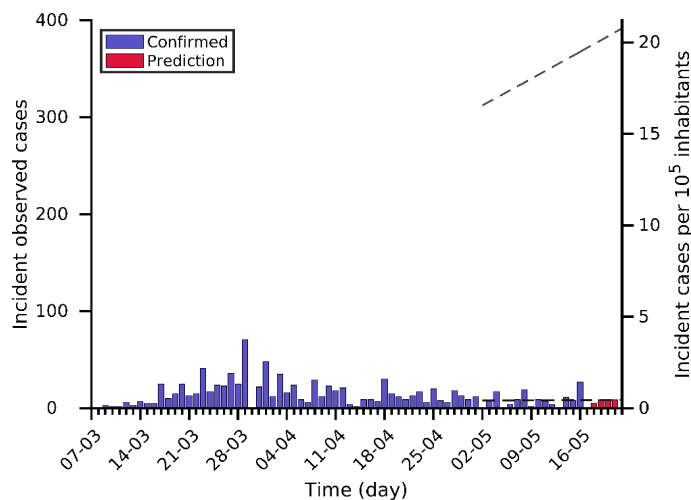
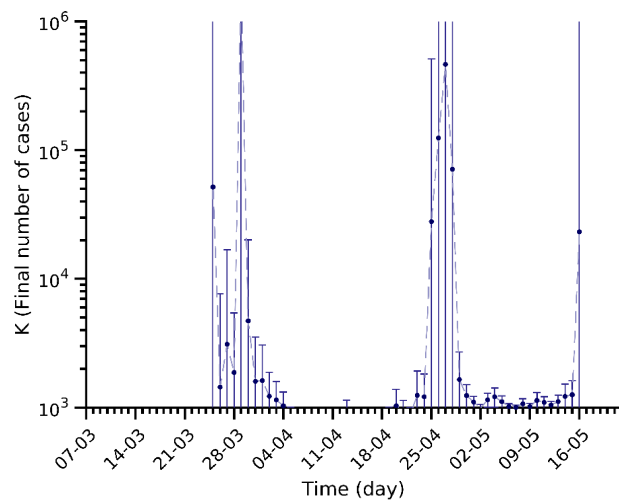
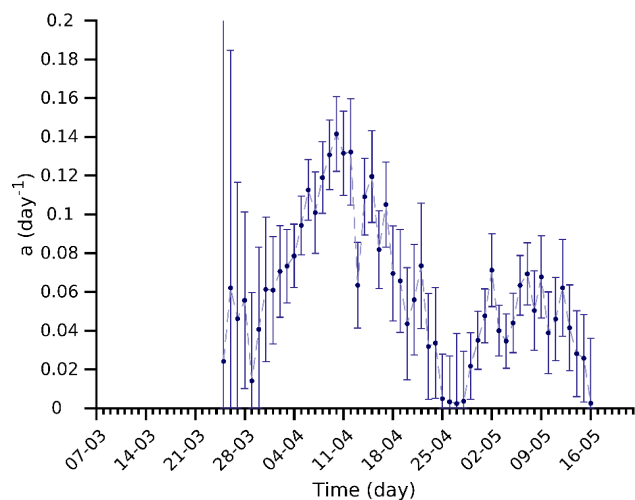
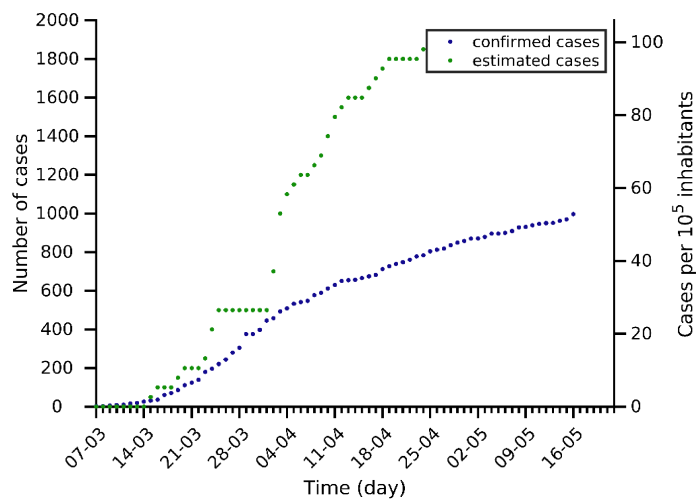
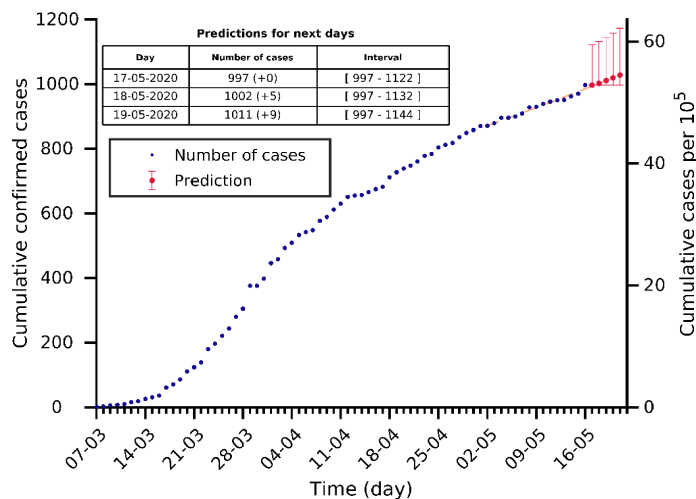
Slovakia 16-05-2020. Population: 5.5M. Current cumulated incidence: 27/10⁵



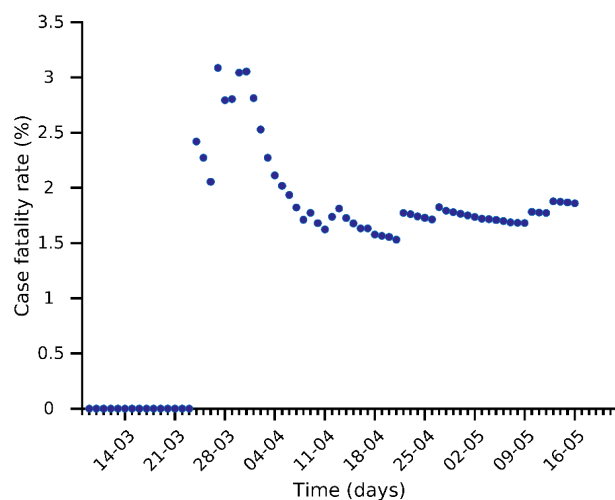
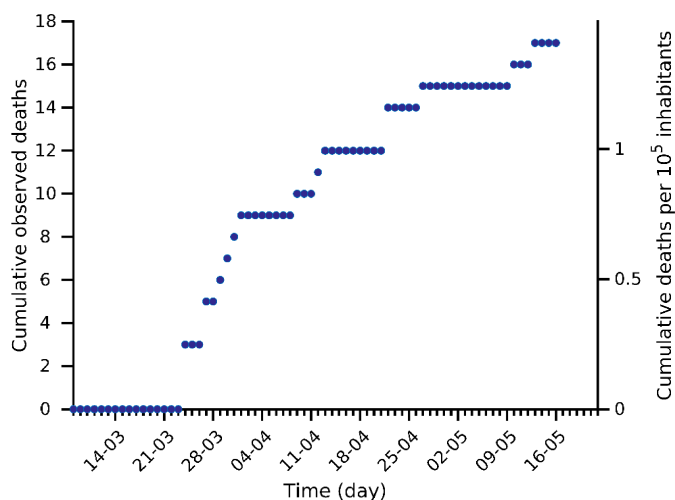
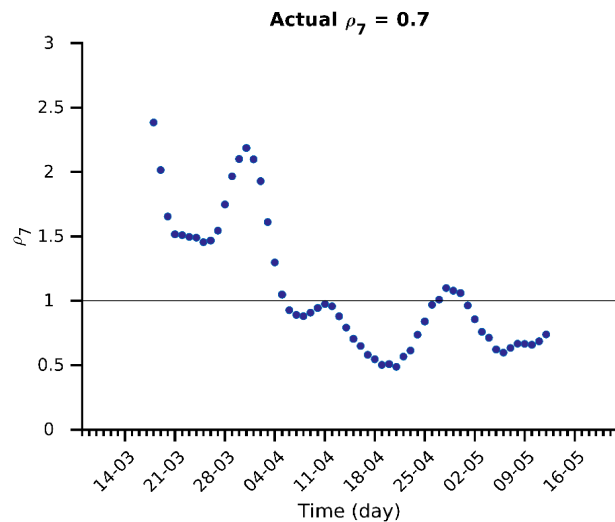
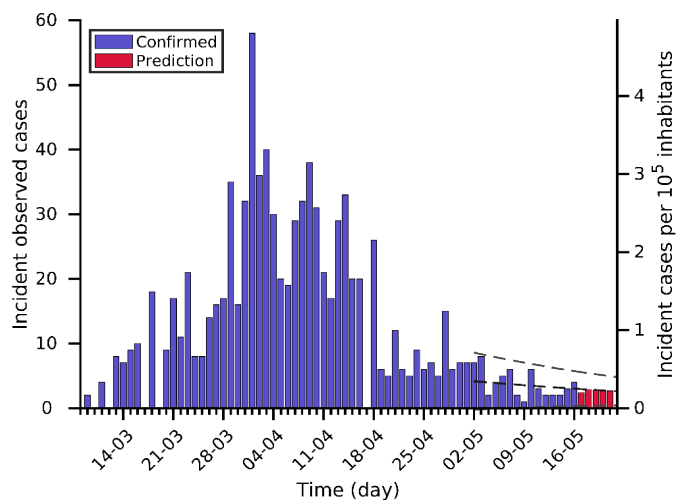
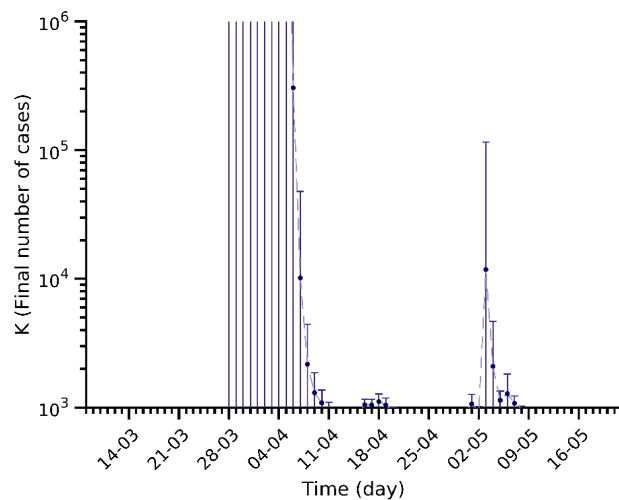
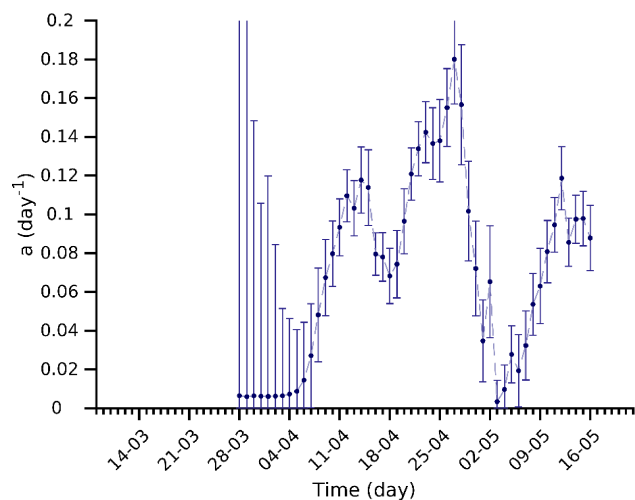
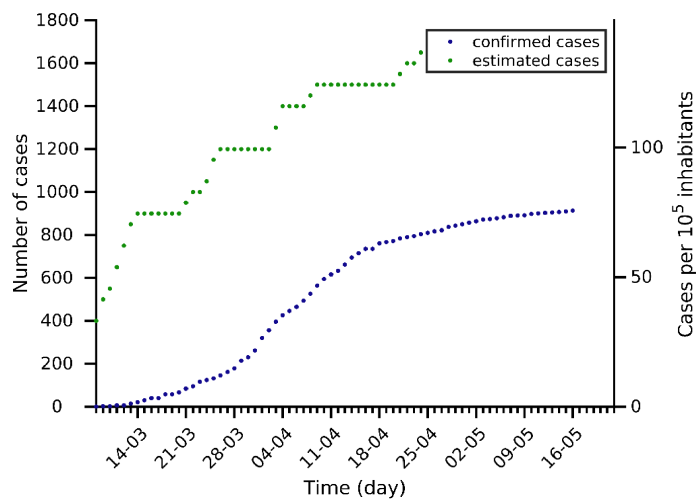
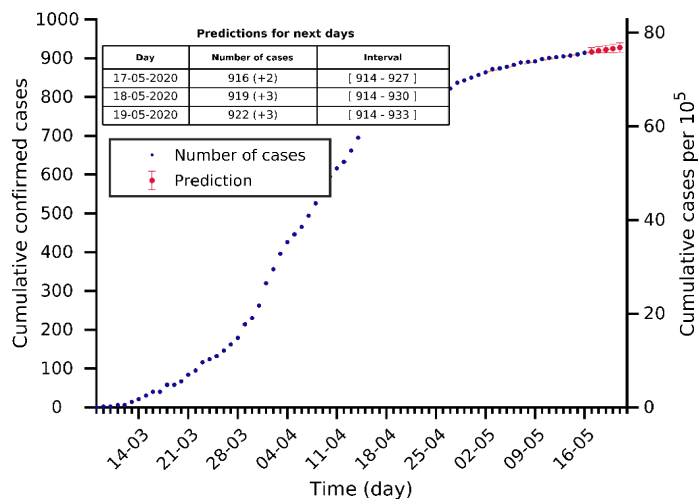
Slovenia 16-05-2020. Population: 2.1M. Current cumulated incidence: 70/10⁵



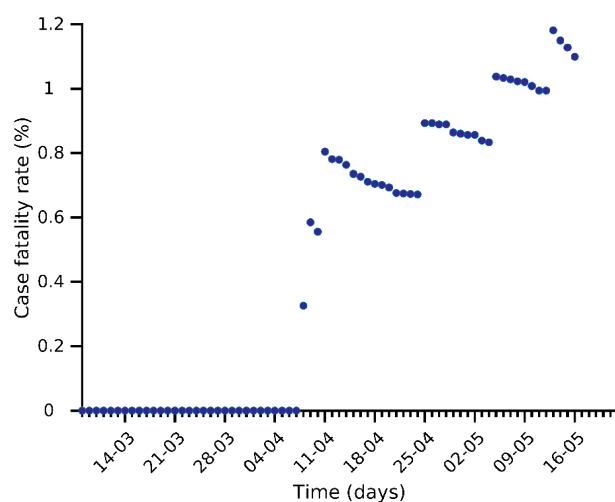
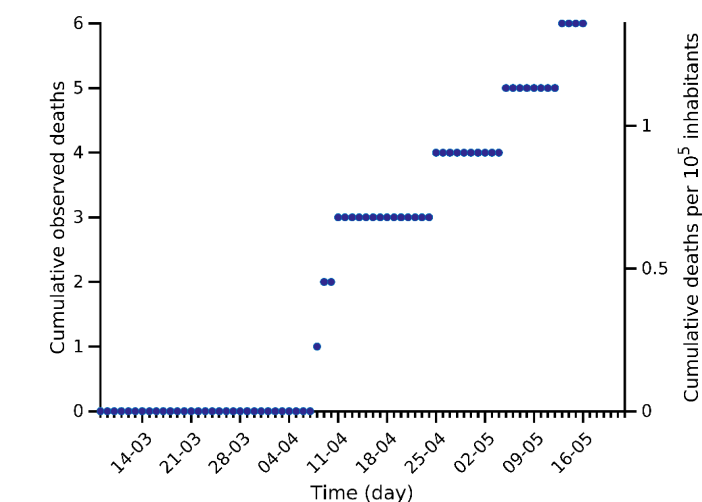
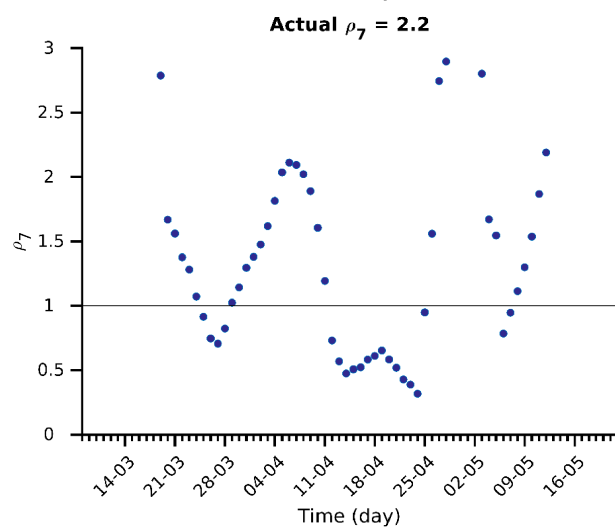
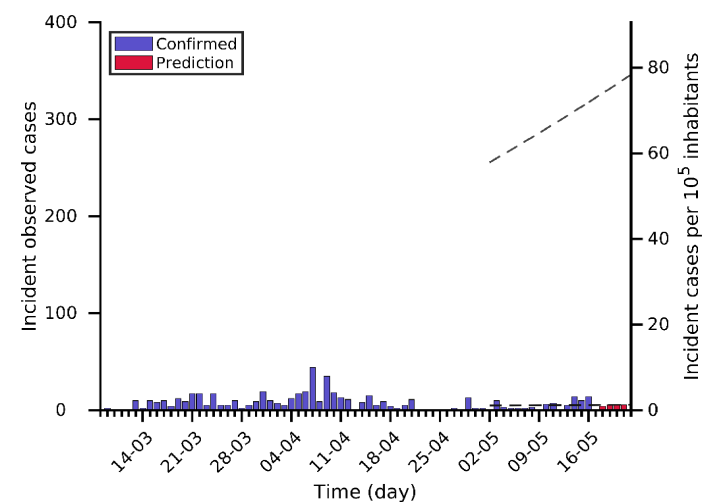
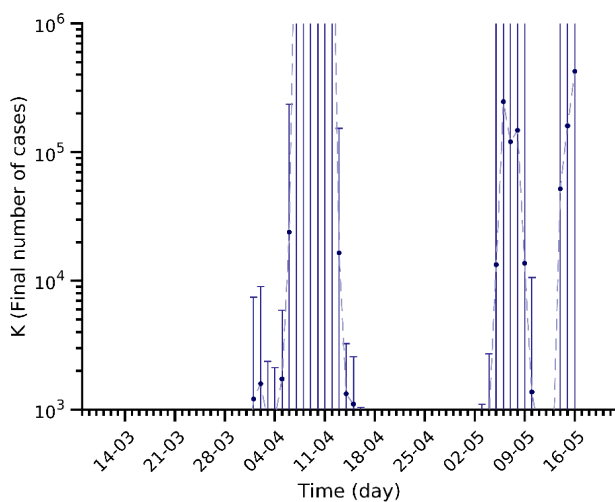
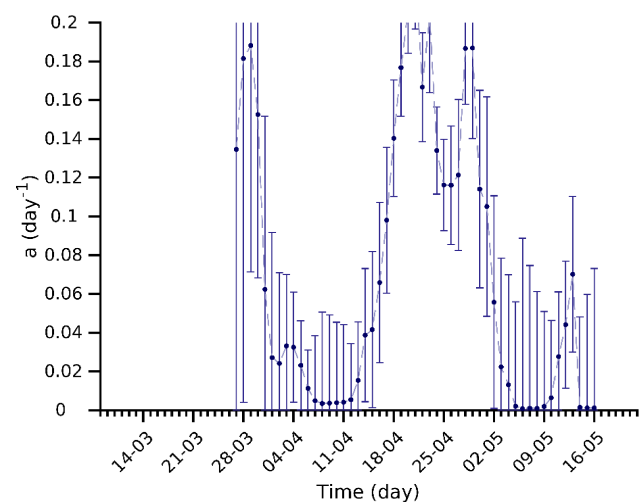
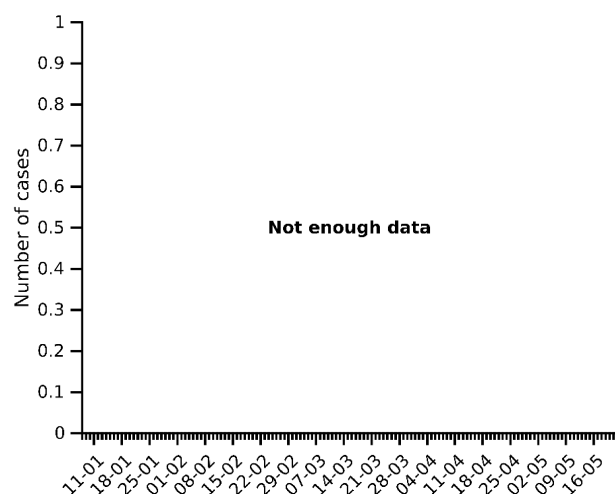
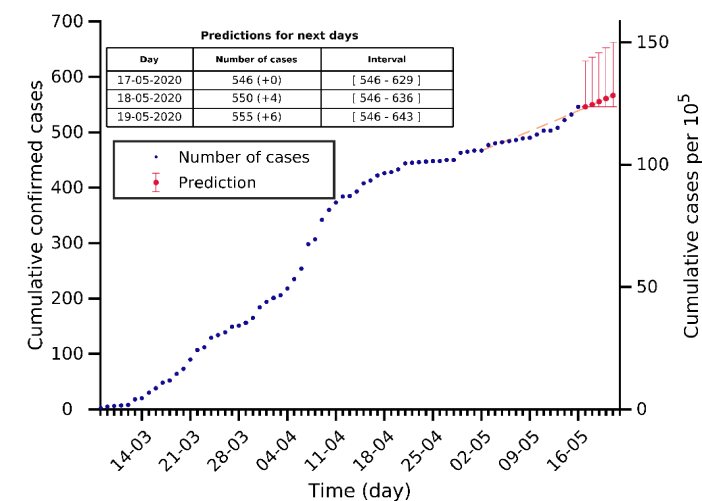
Latvia 16-05-2020. Population: 1.9M. Current cumulated incidence: 53/10⁵



Cyprus 16-05-2020. Population: 1.2M. Current cumulated incidence: 76/10⁵



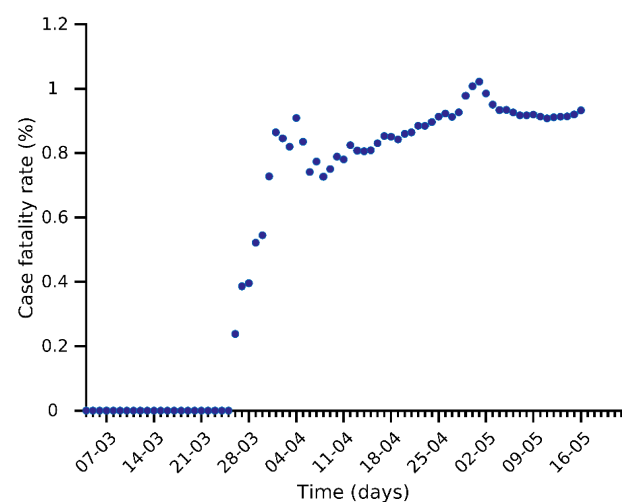
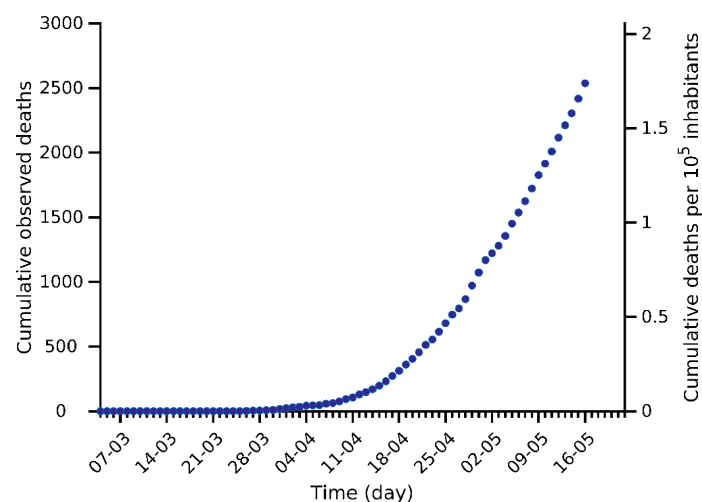
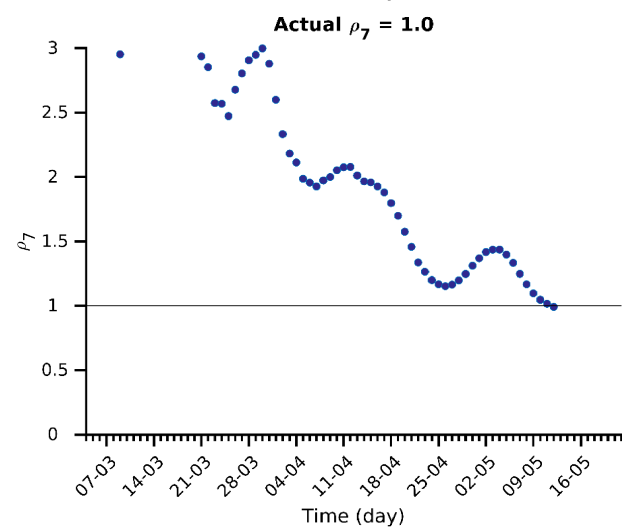
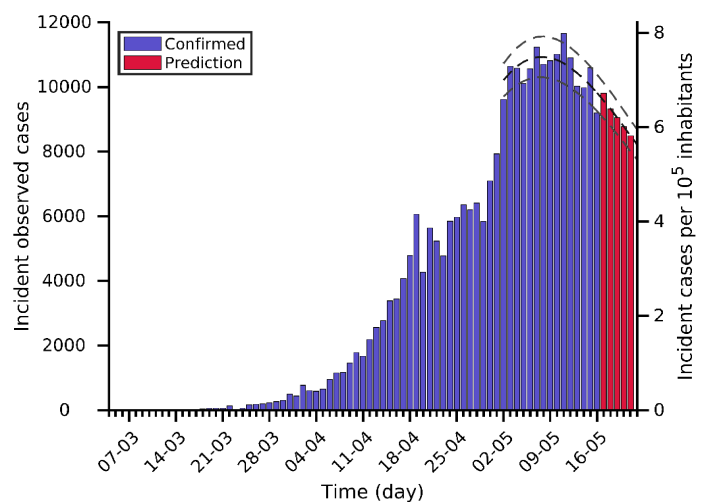
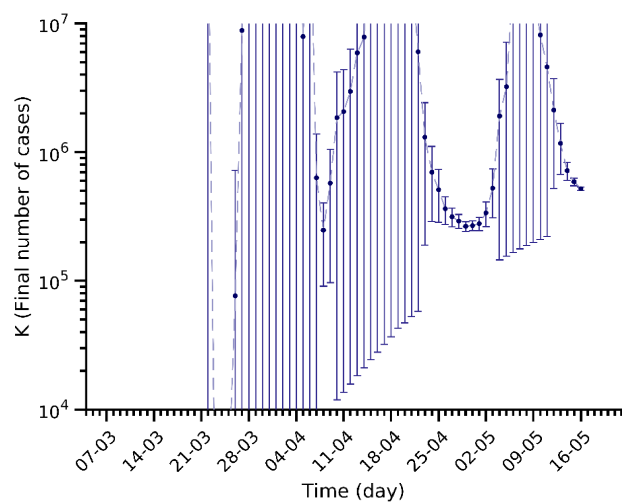
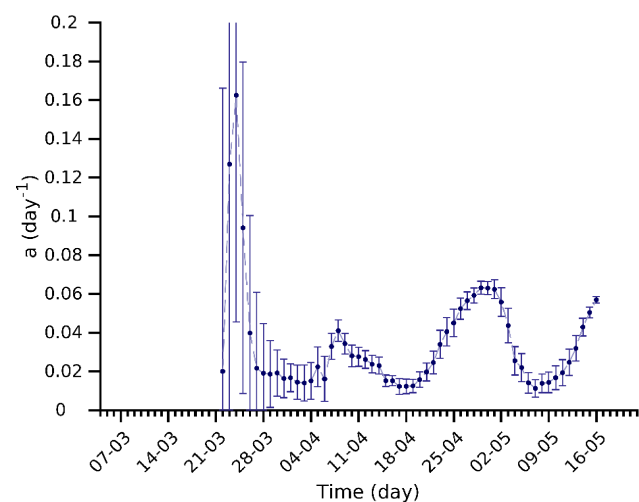
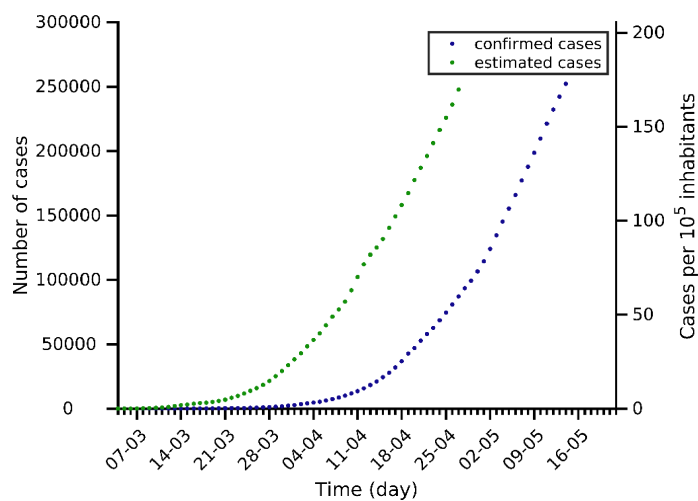
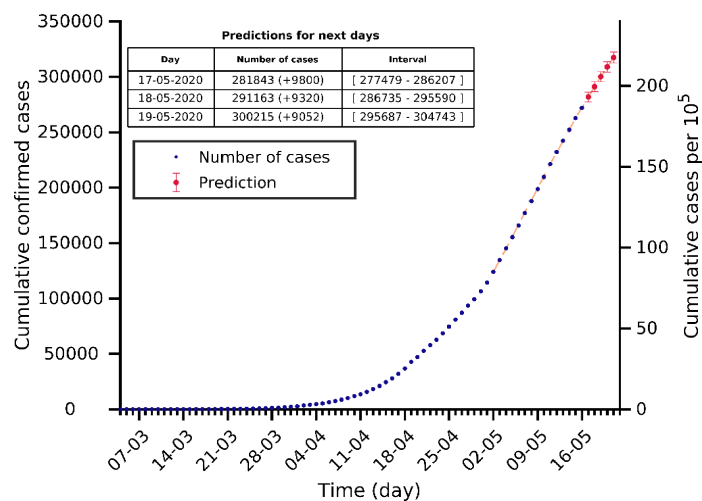
Malta 16-05-2020. Population: 0.4M. Current cumulated incidence: 124/10⁵



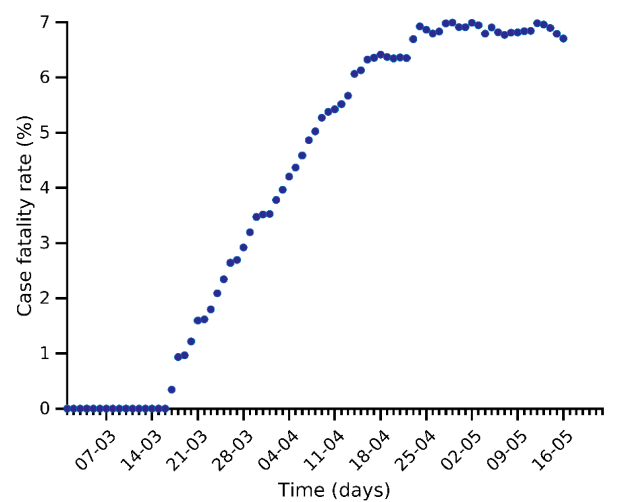
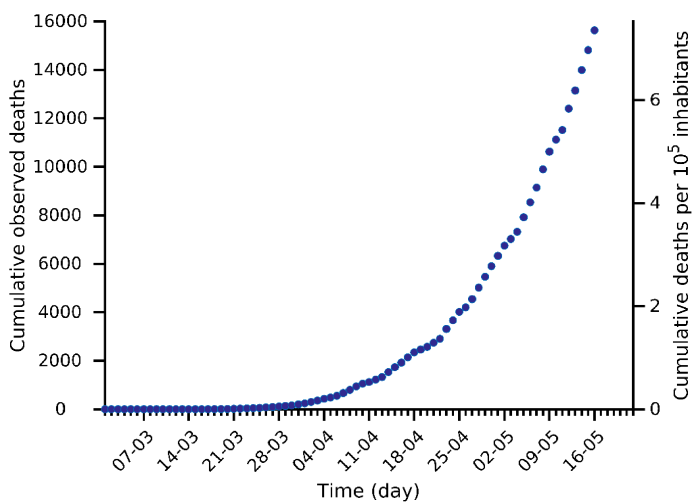
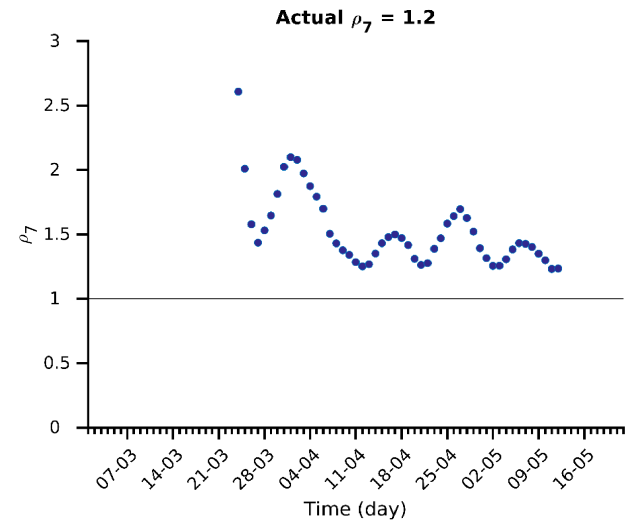
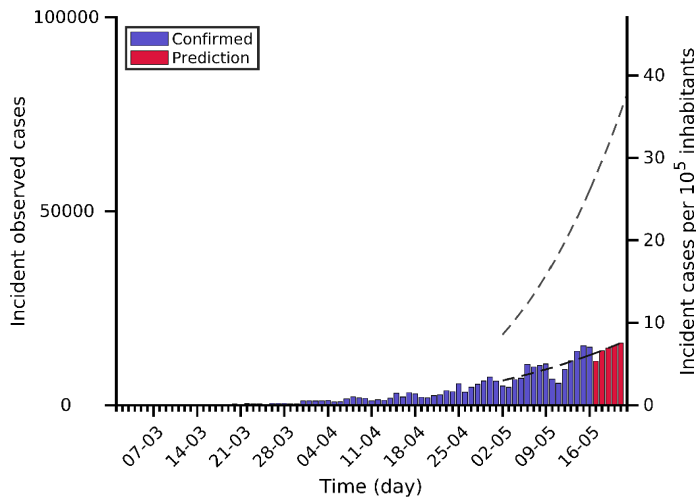
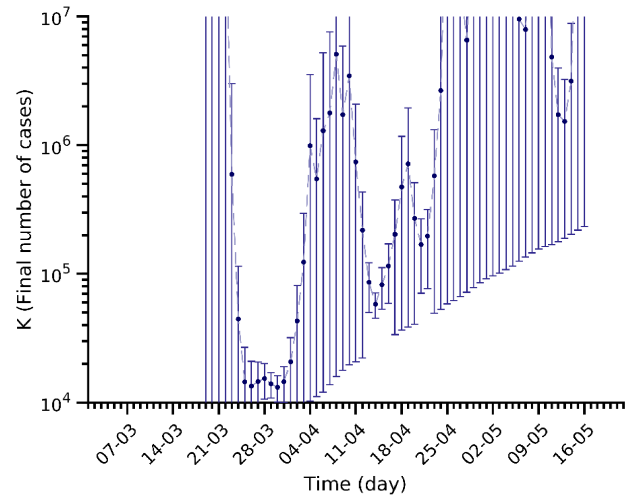
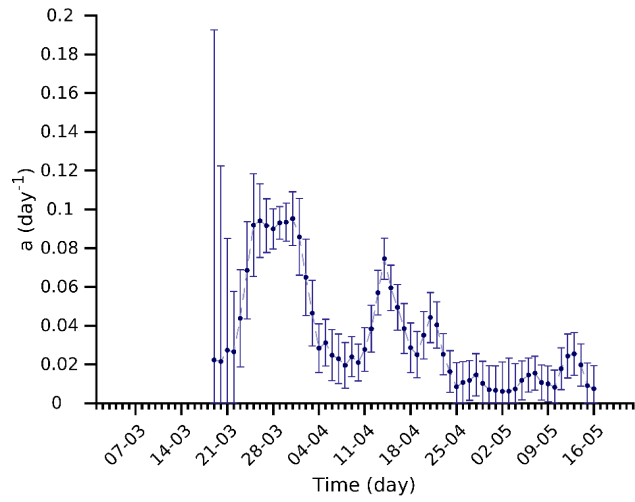
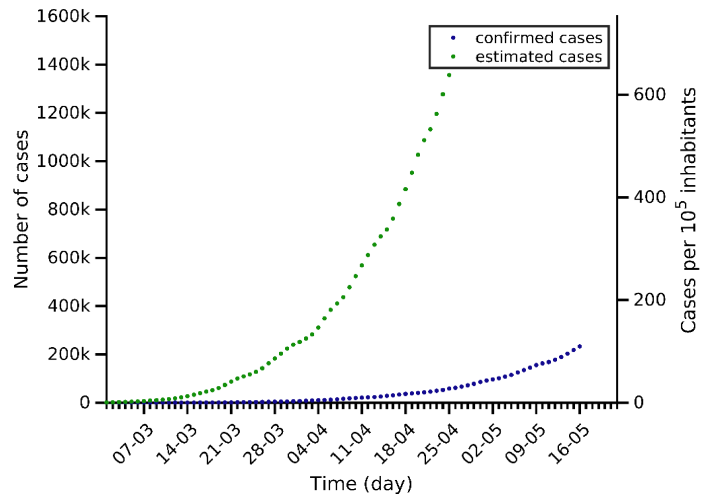
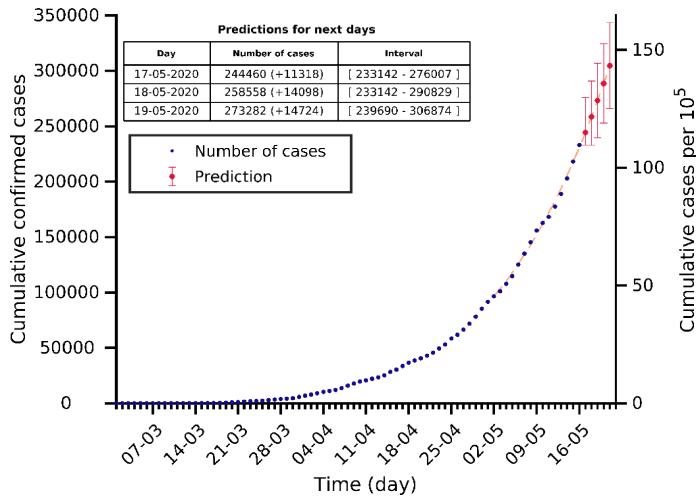
(2) Analysis and prediction of COVID-19 for other countries

Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

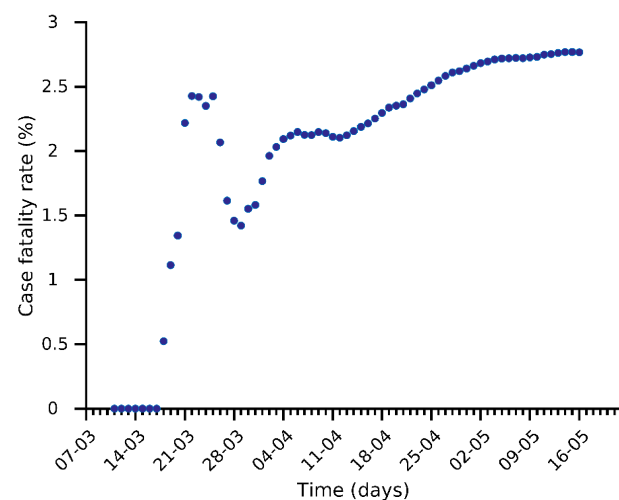
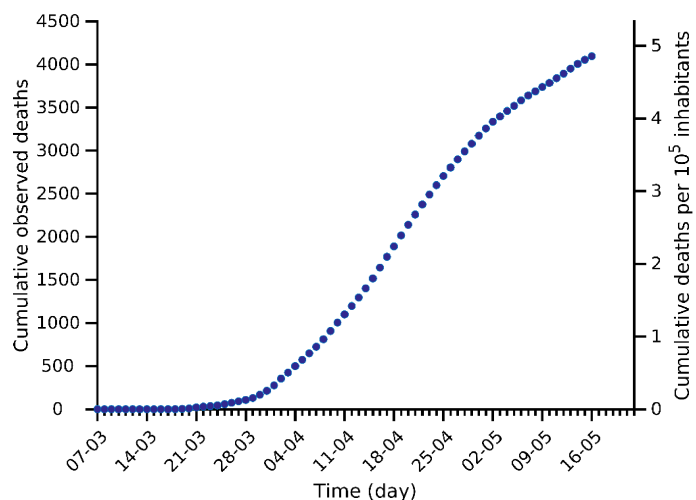
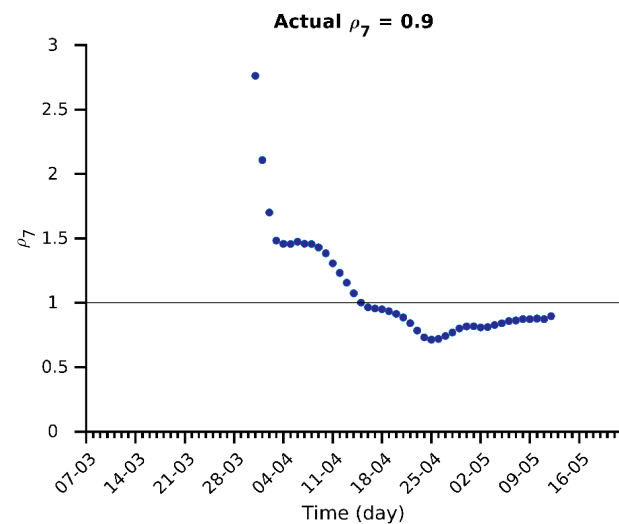
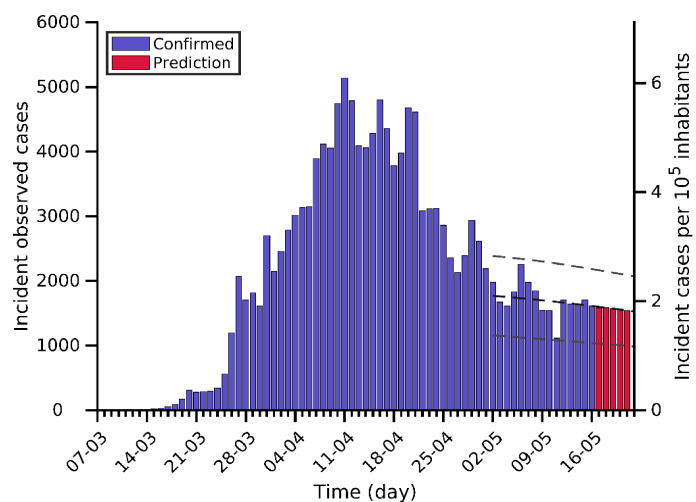
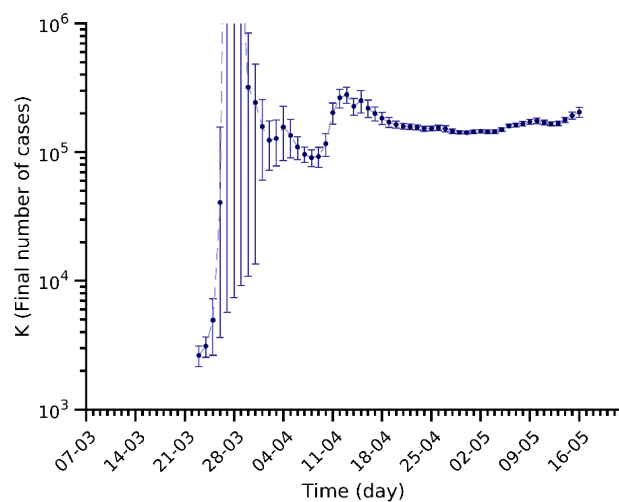
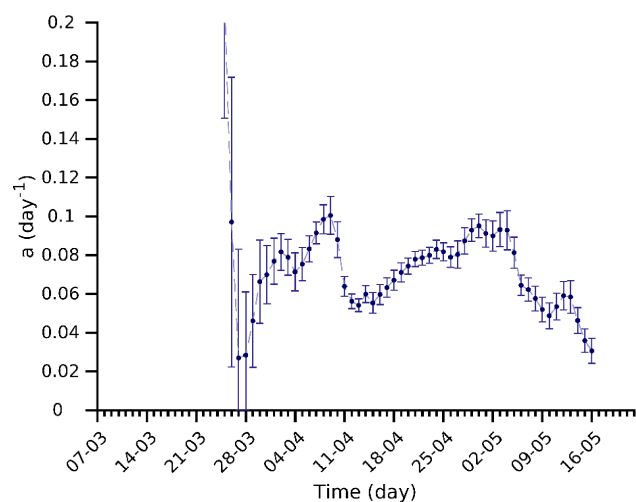
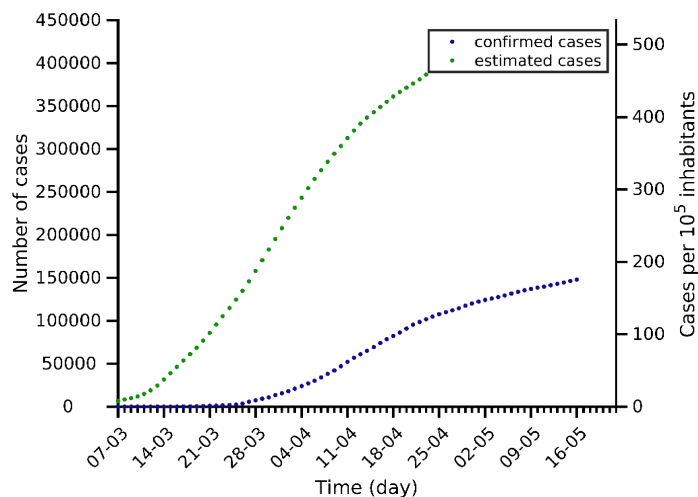
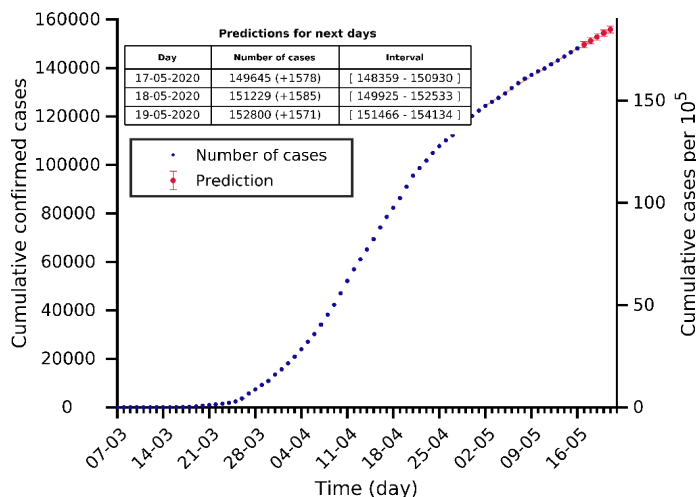
Russia 16-05-2020. Population: 145.9M. Current cumulated incidence: 186/10⁵



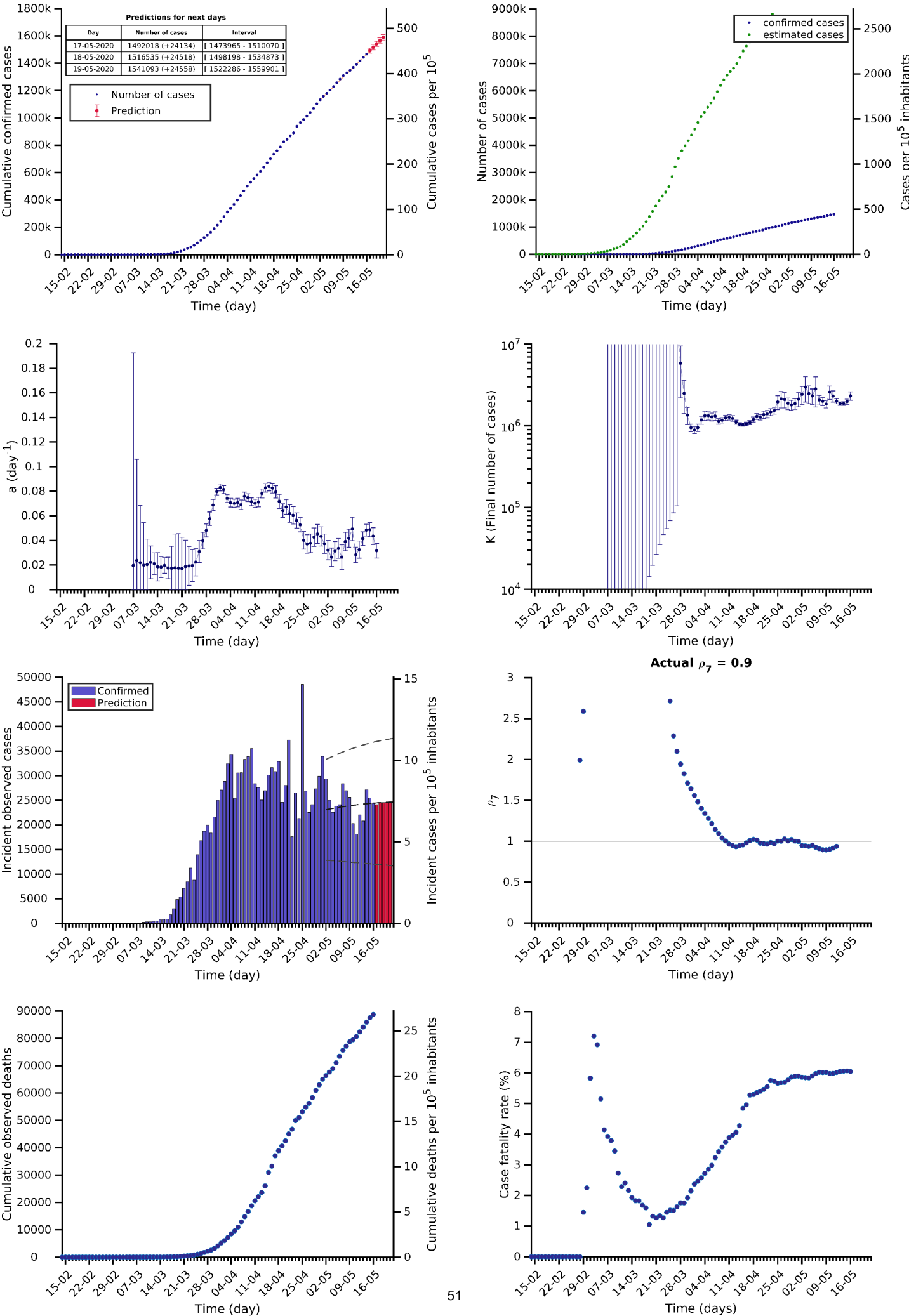
Brazil 16-05-2020. Population: 212.6M. Current cumulated incidence: 110/10⁵



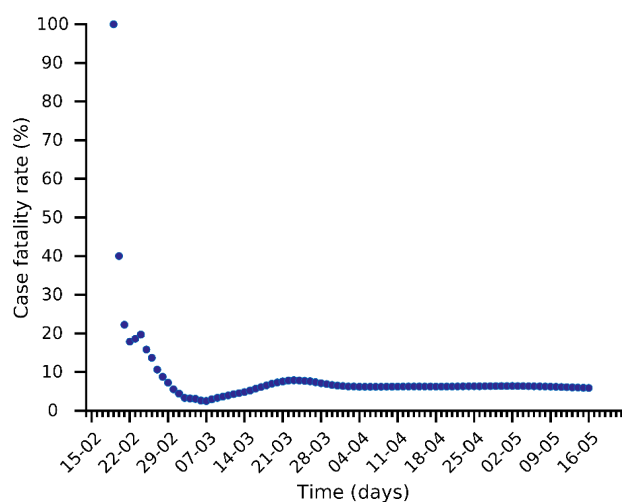
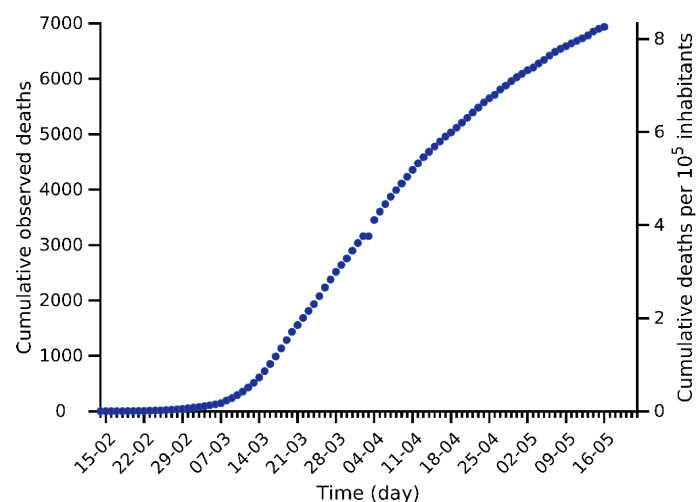
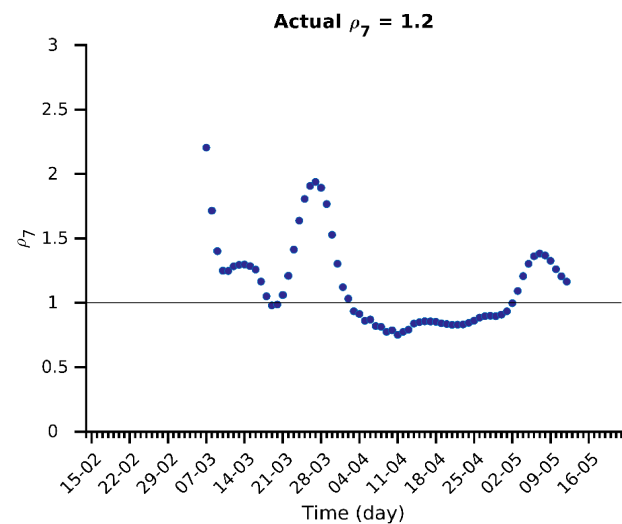
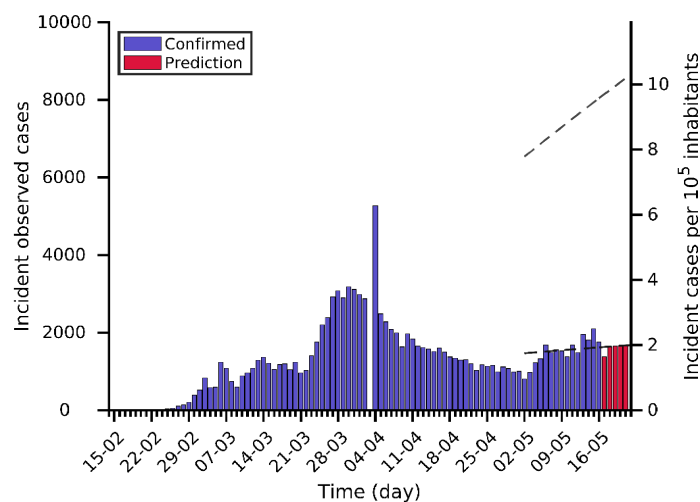
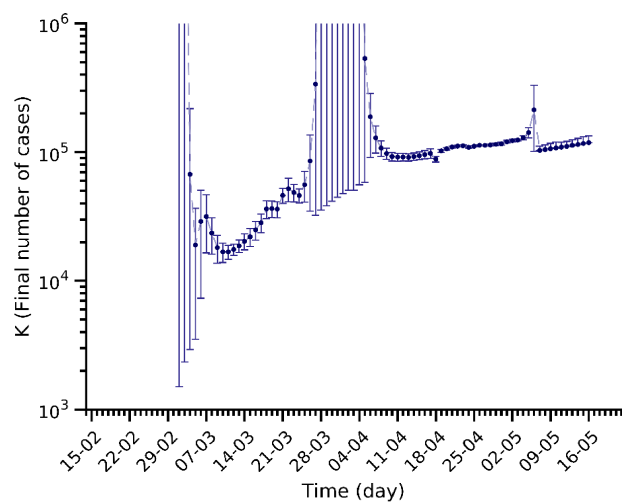
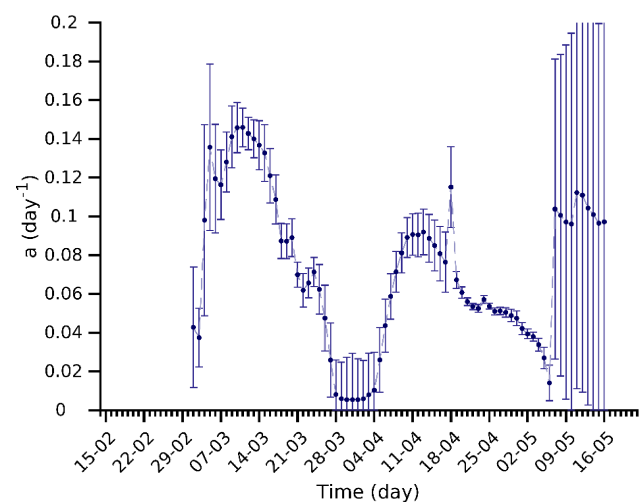
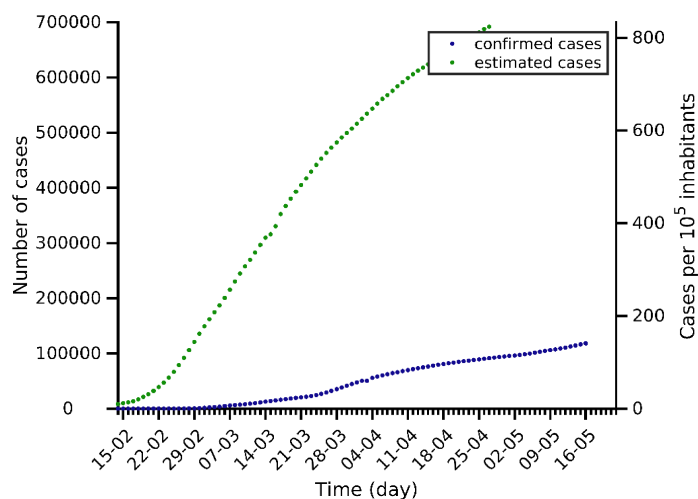
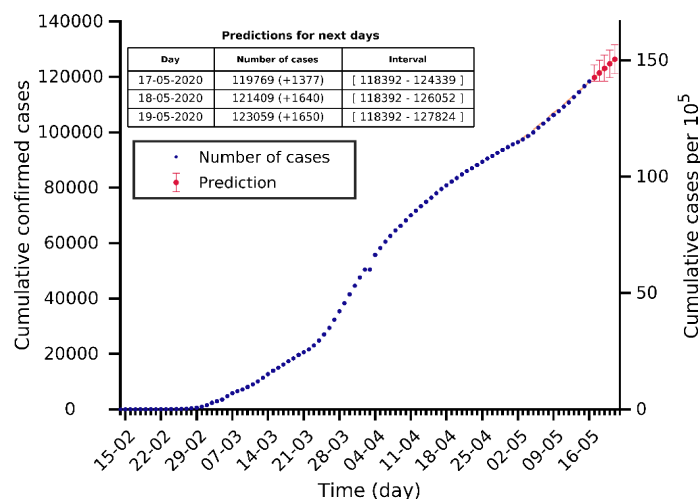
Turkey 16-05-2020. Population: 84.3M. Current cumulated incidence: 176/10⁵



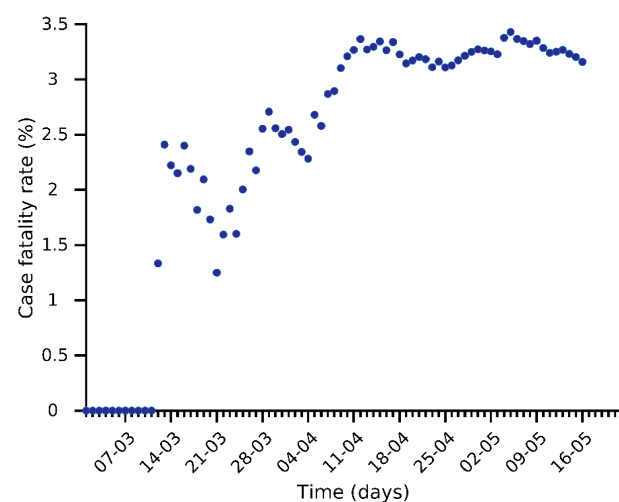
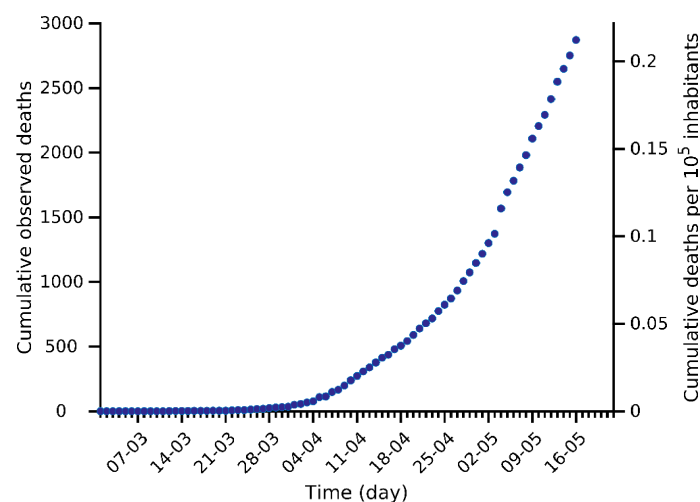
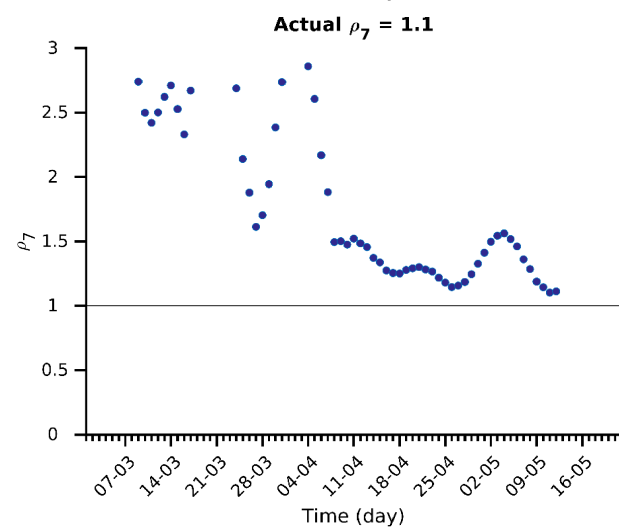
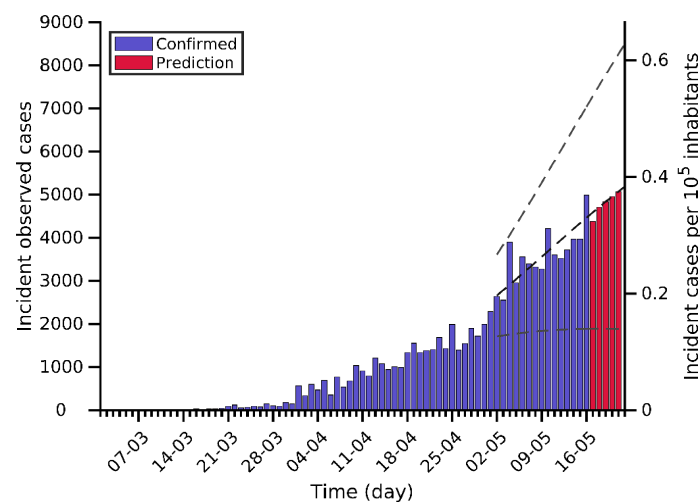
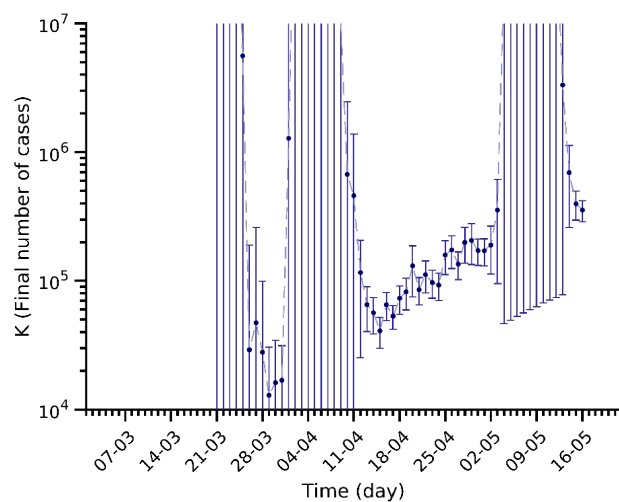
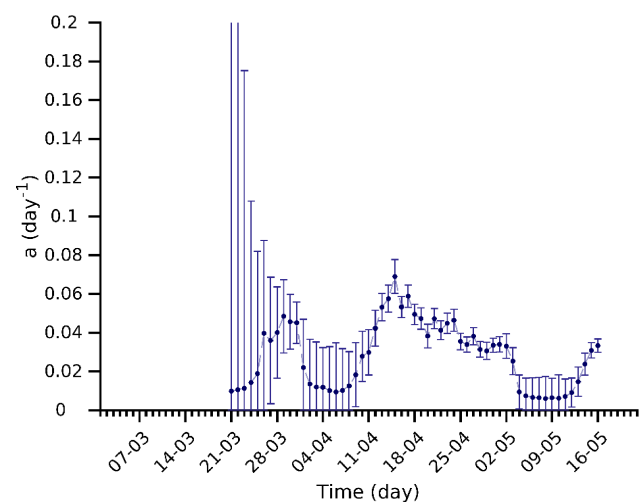
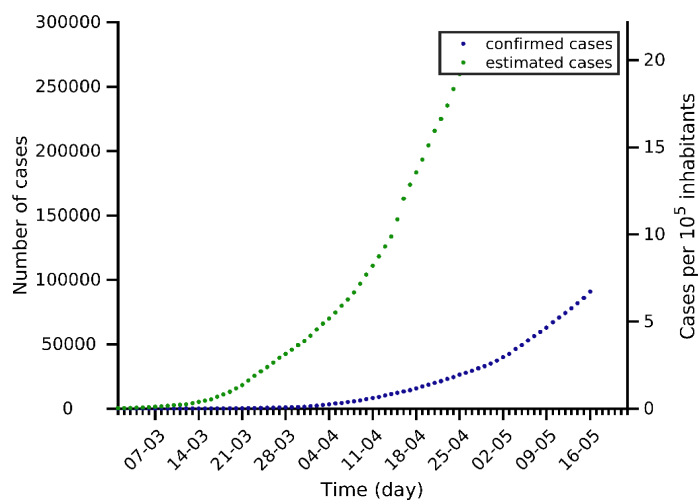
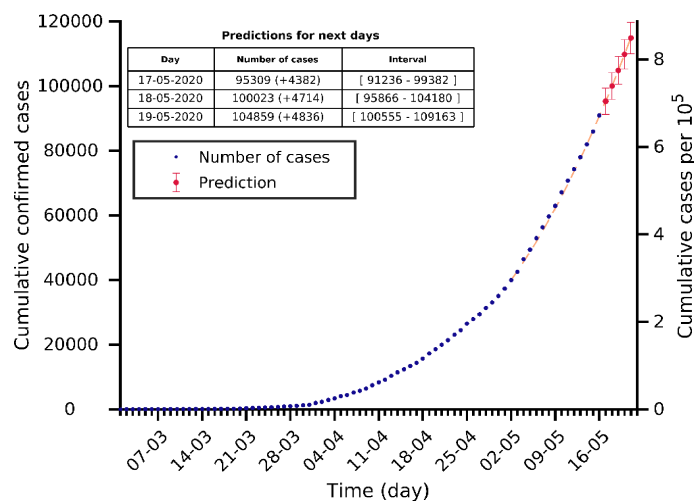
USA 16-05-2020. Population: 331.0M. Current cumulated incidence: 443/10⁵



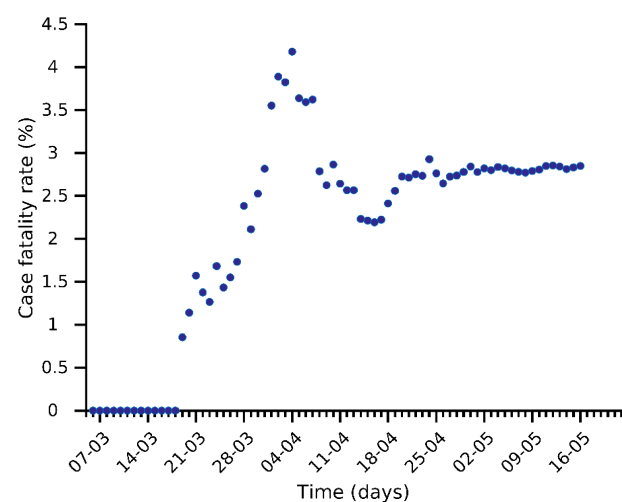
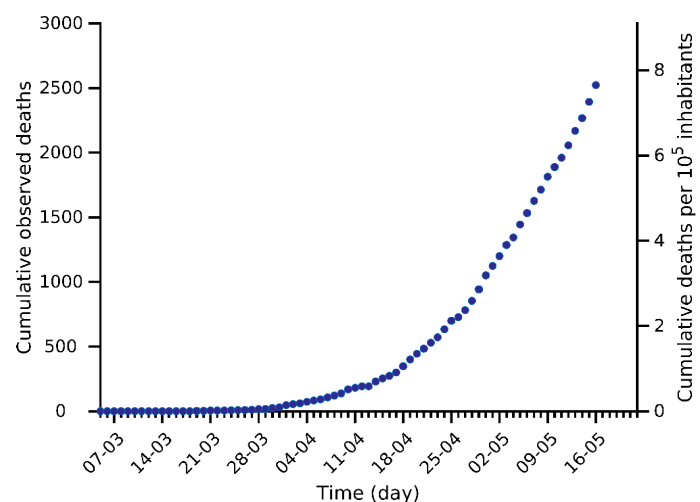
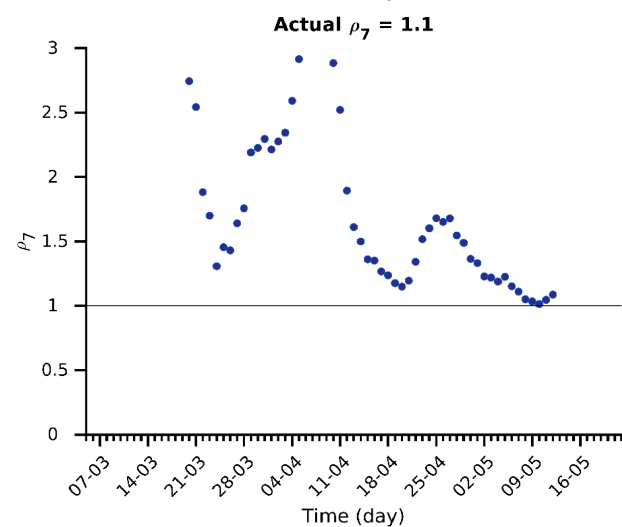
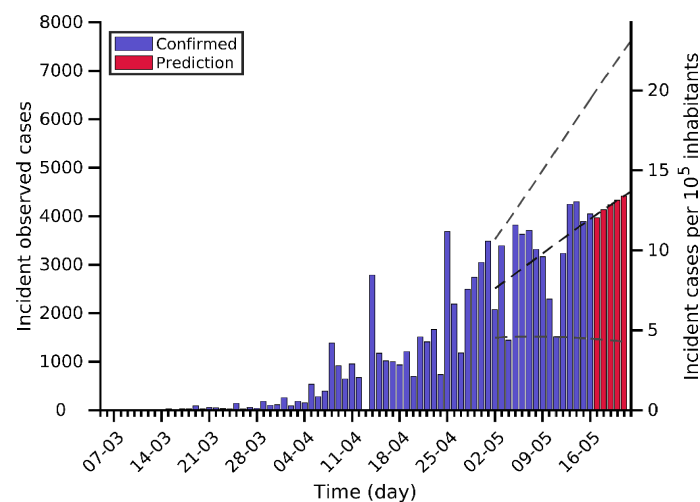
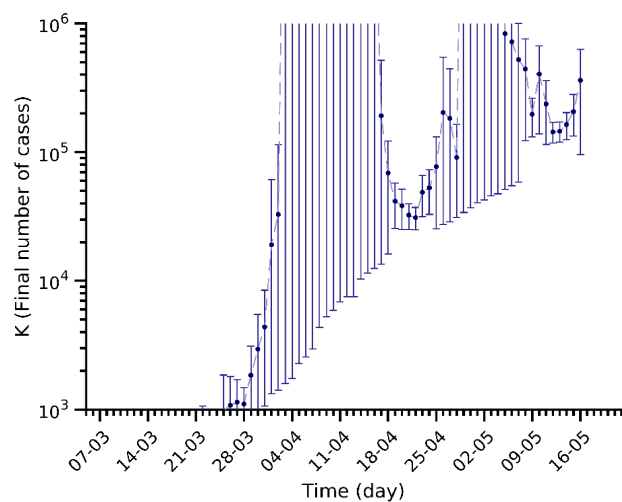
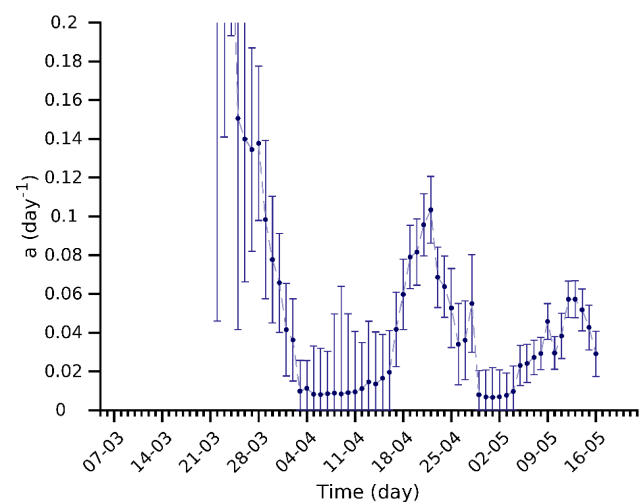
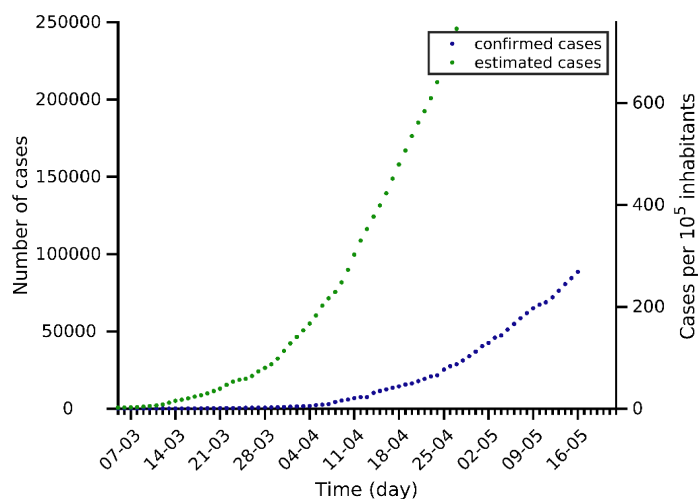
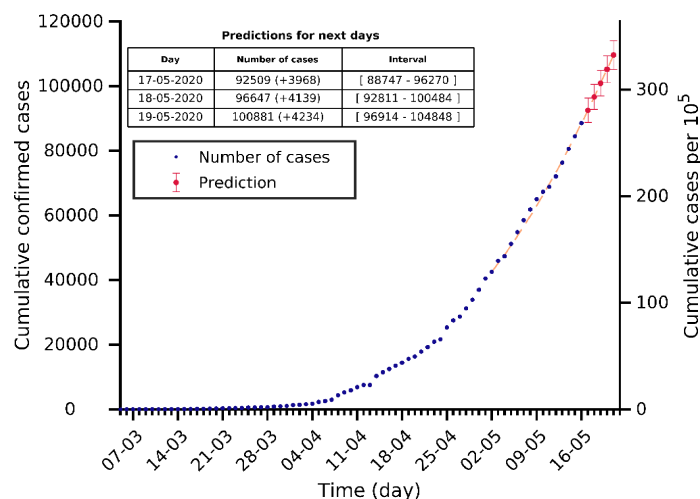
Iran 16-05-2020. Population: 84.0M. Current cumulated incidence: 141/10⁵



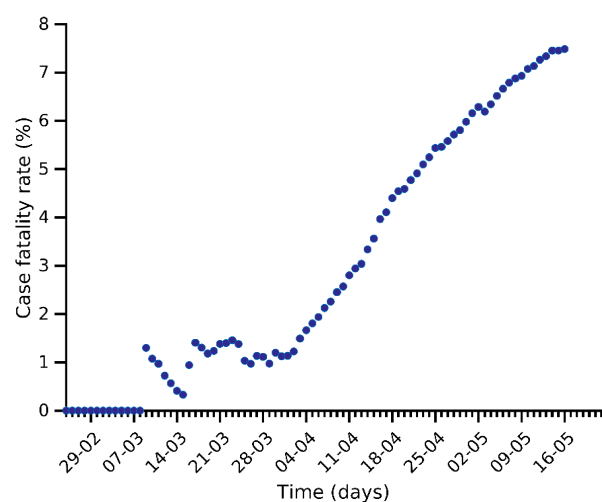
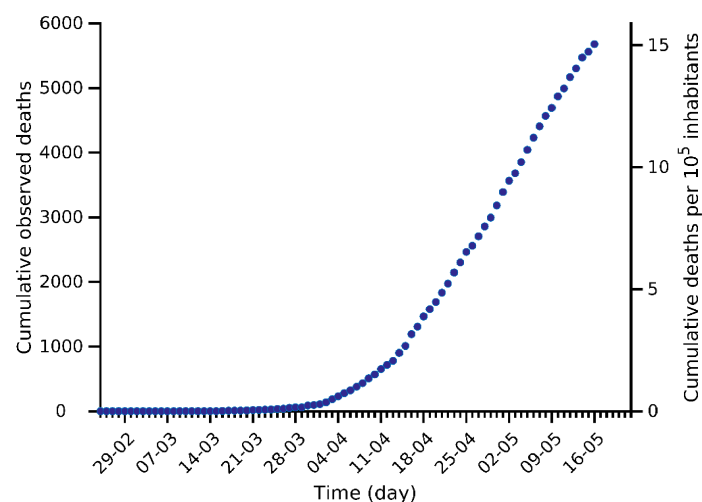
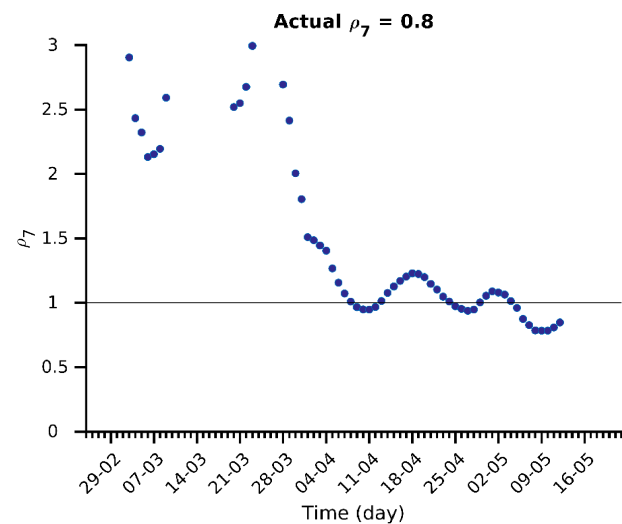
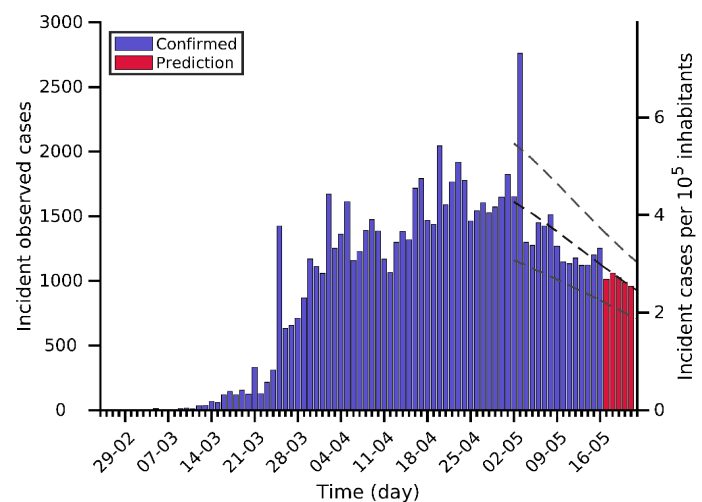
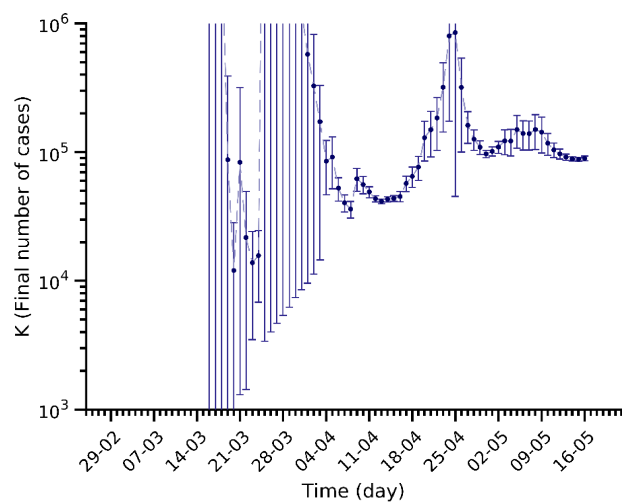
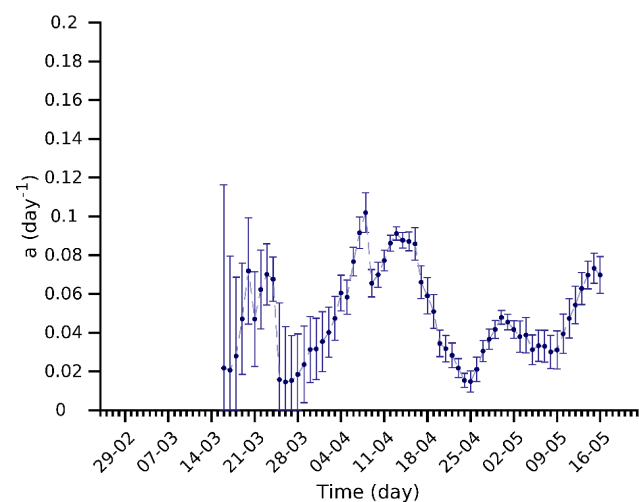
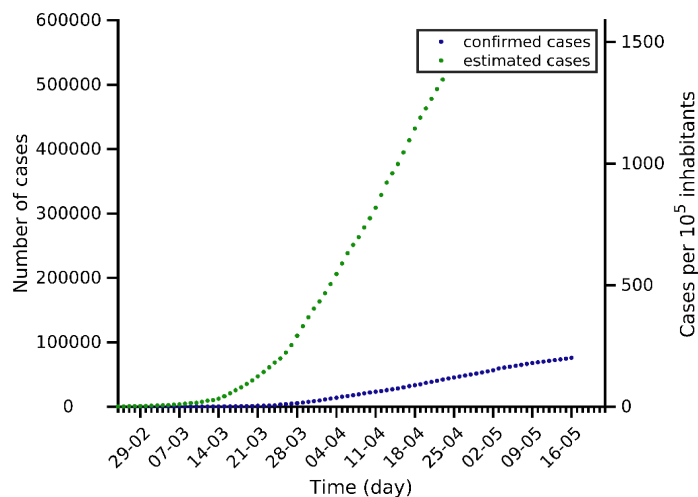
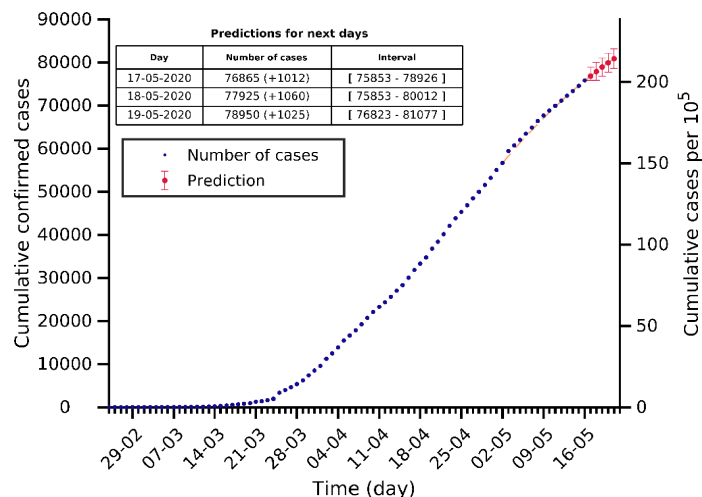
India 16-05-2020. Population: 1353.0M. Current cumulated incidence: 7/10⁵



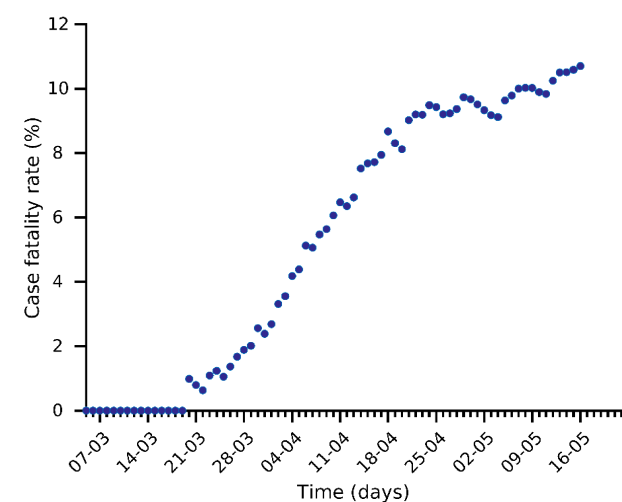
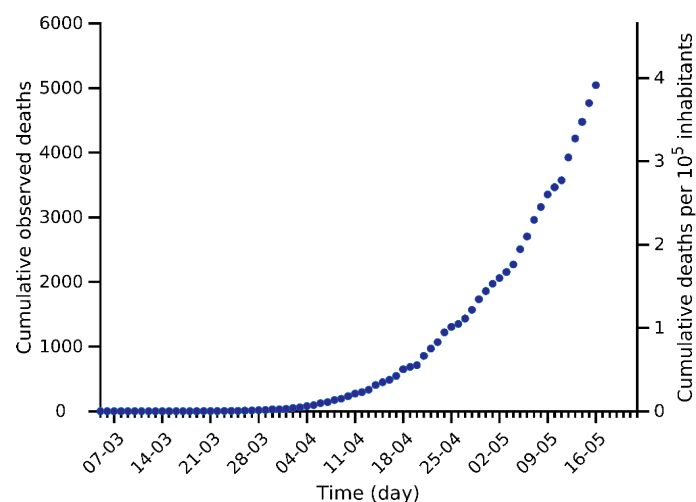
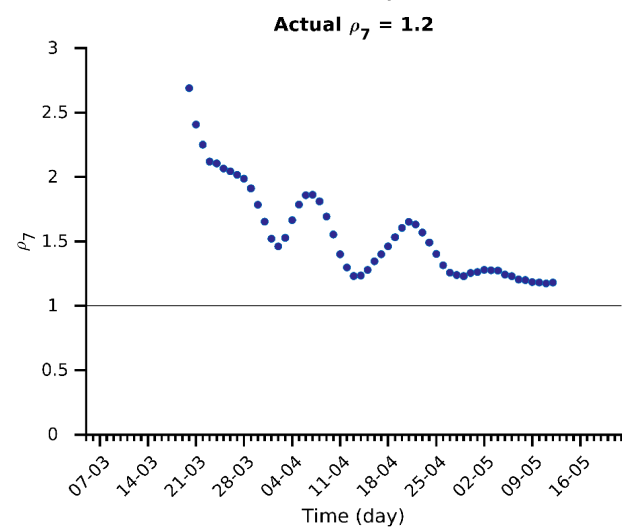
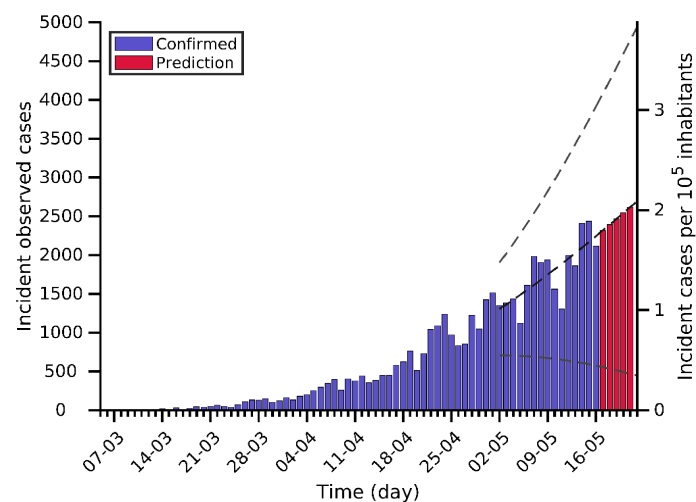
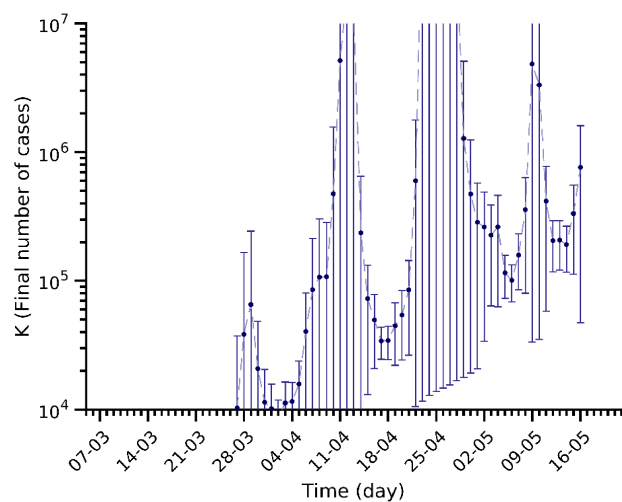
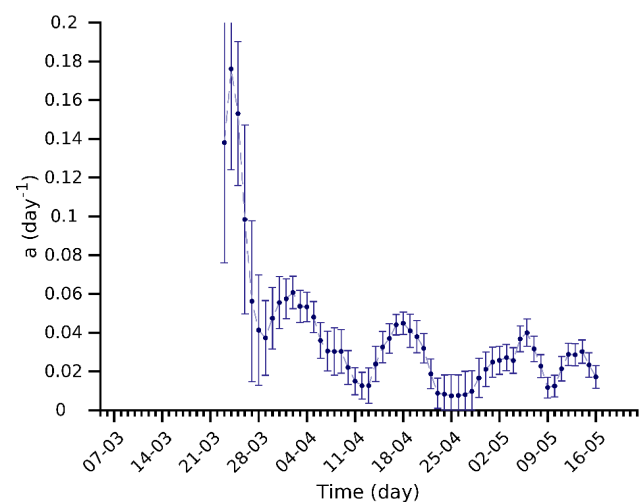
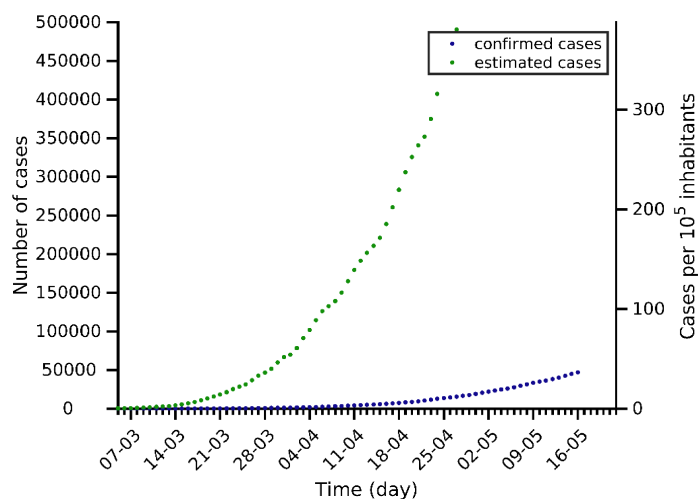
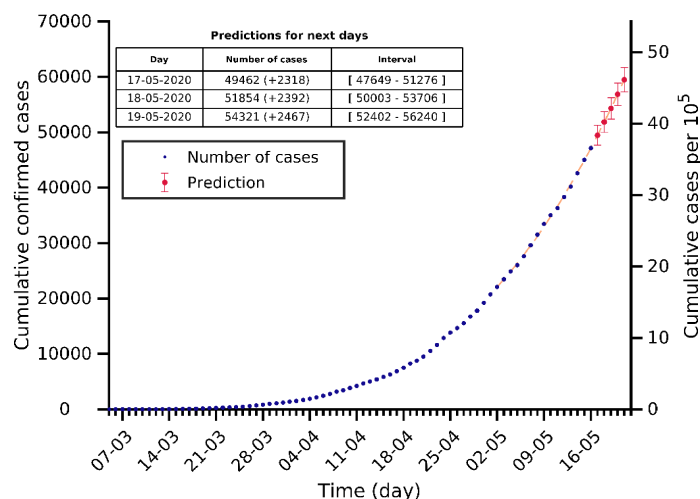
Peru 16-05-2020. Population: 33.0M. Current cumulated incidence: 269/10⁵



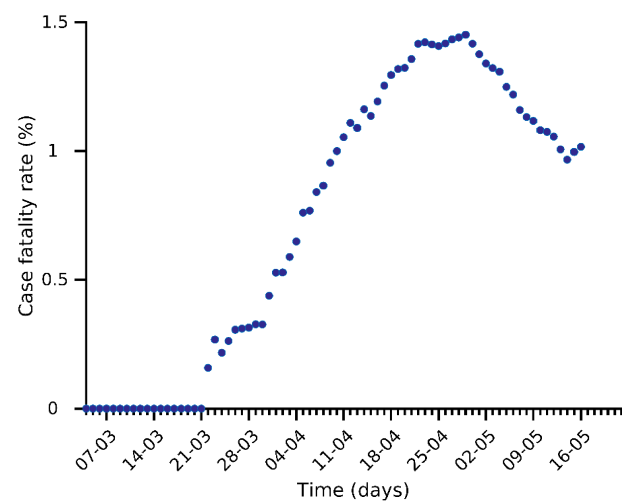
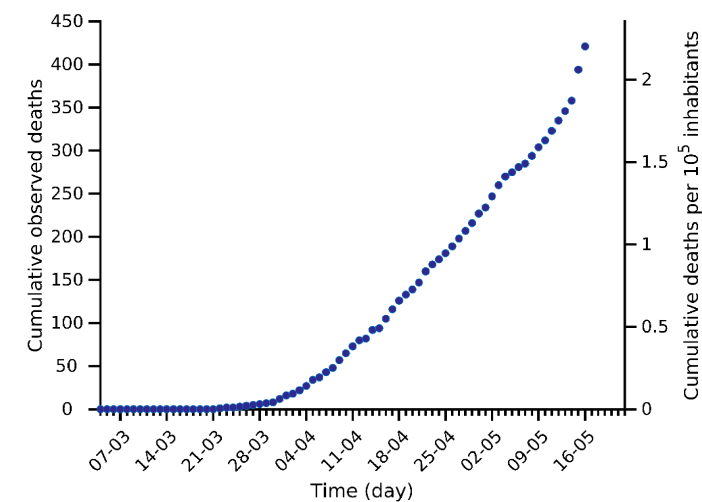
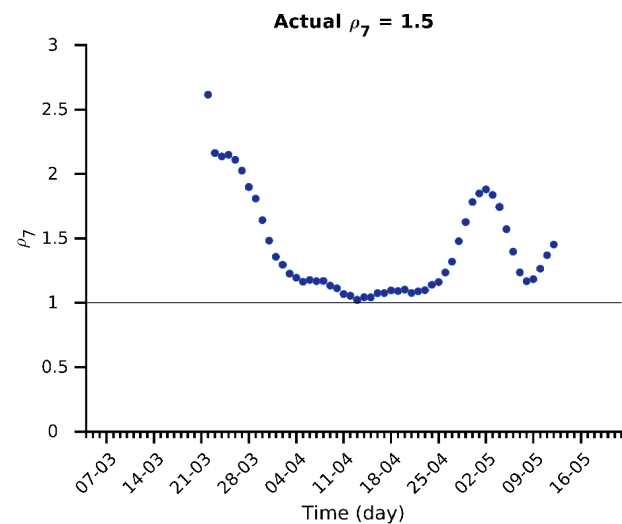
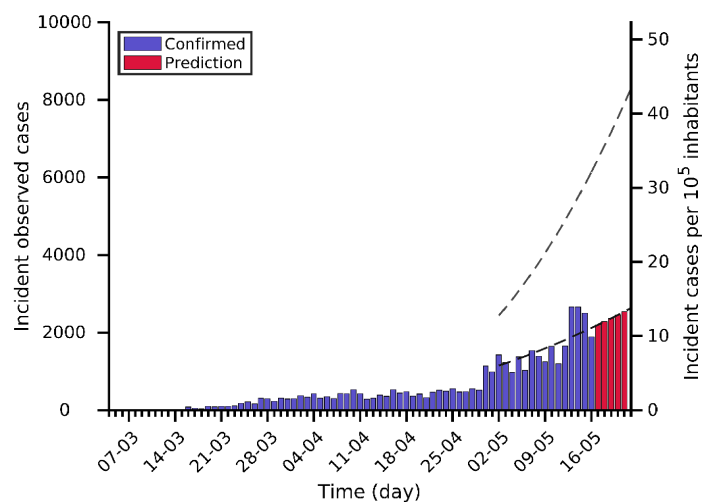
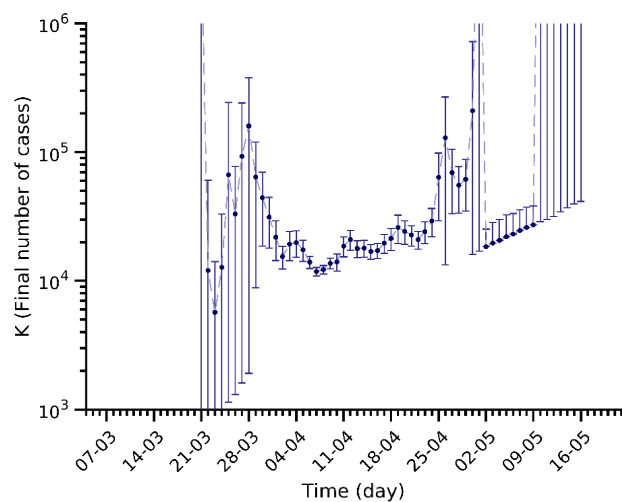
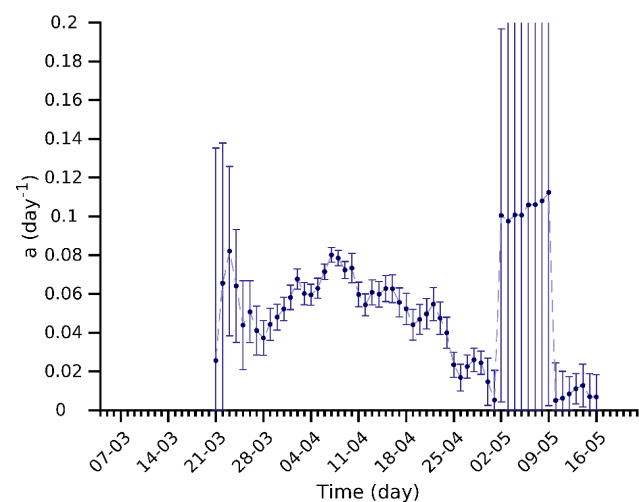
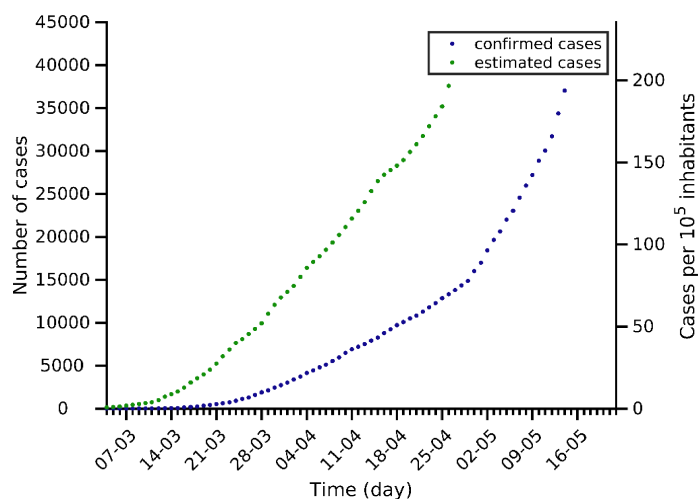
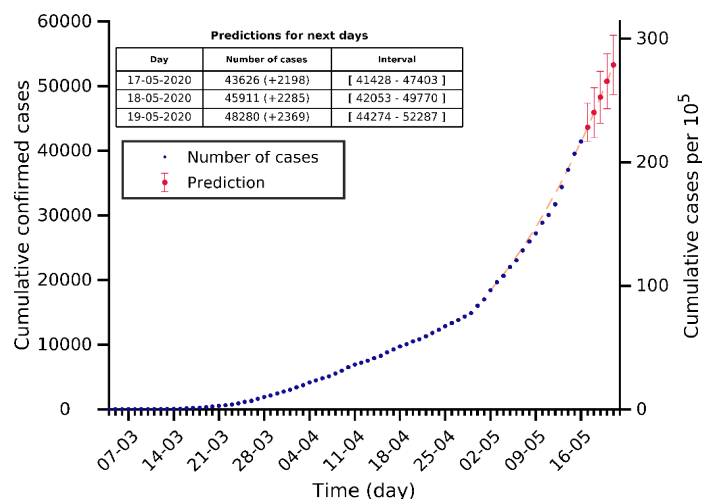
Canada 16-05-2020. Population: 37.7M. Current cumulated incidence: 201/10⁵



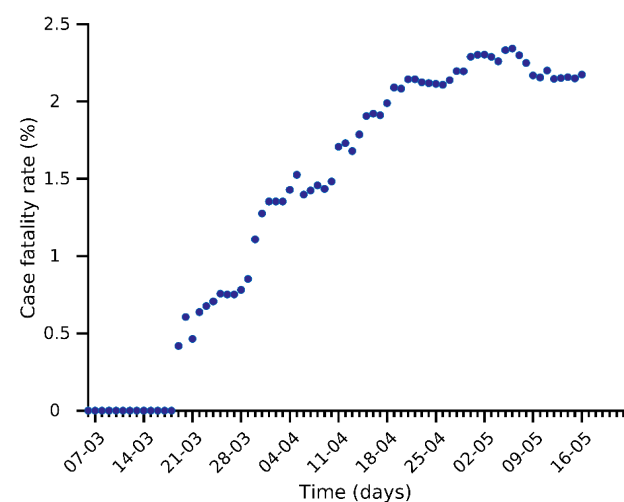
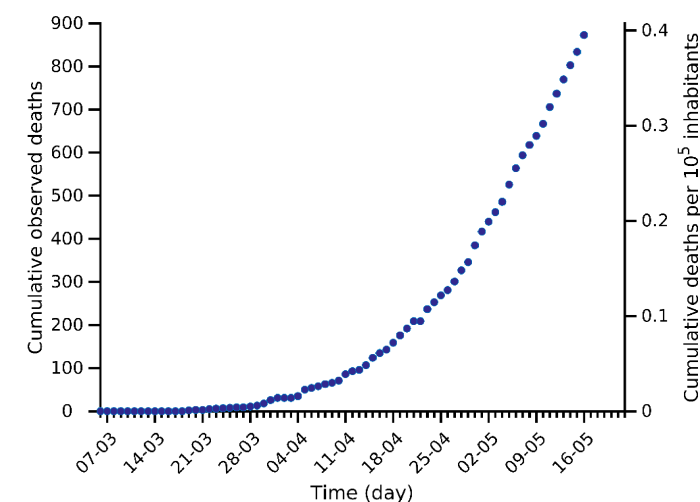
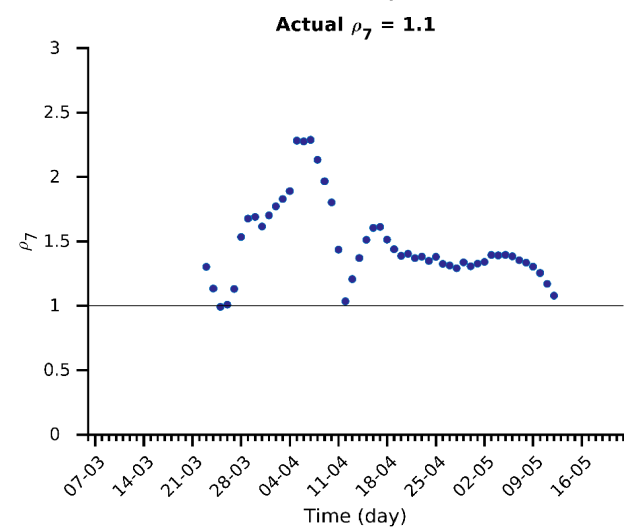
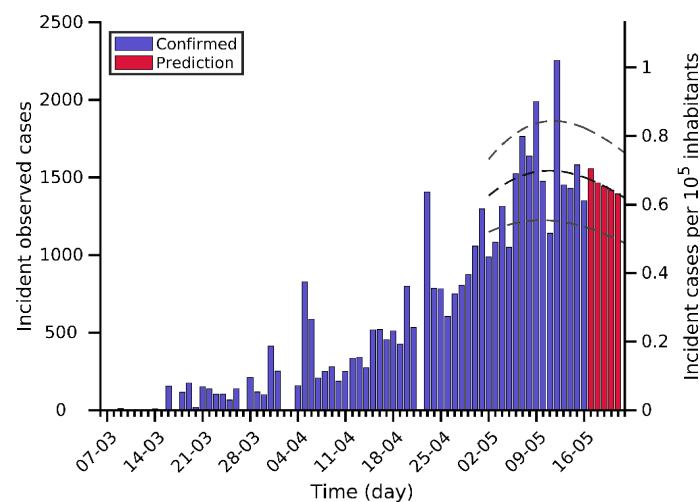
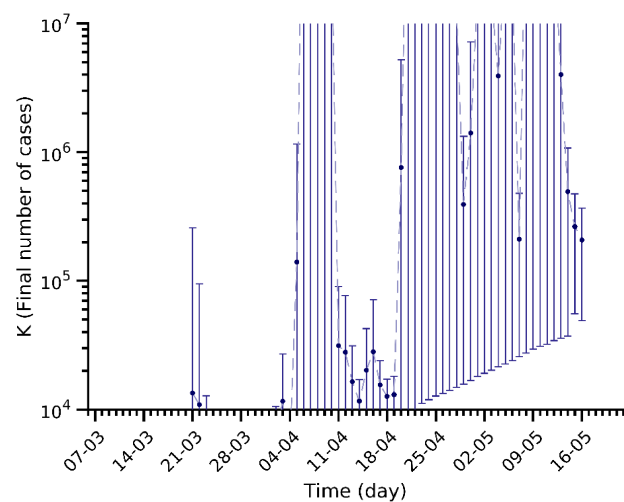
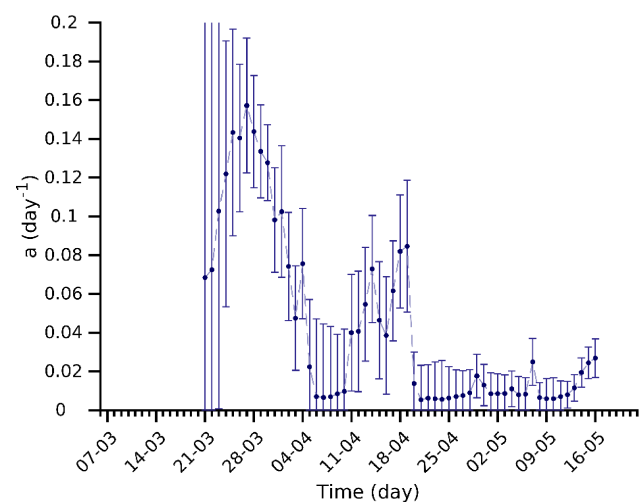
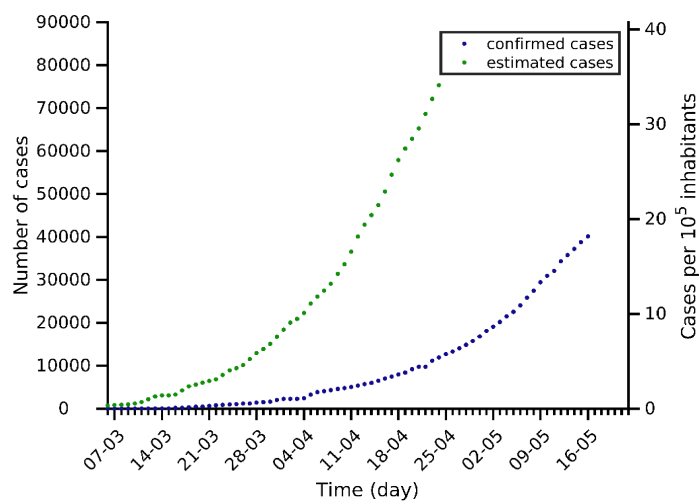
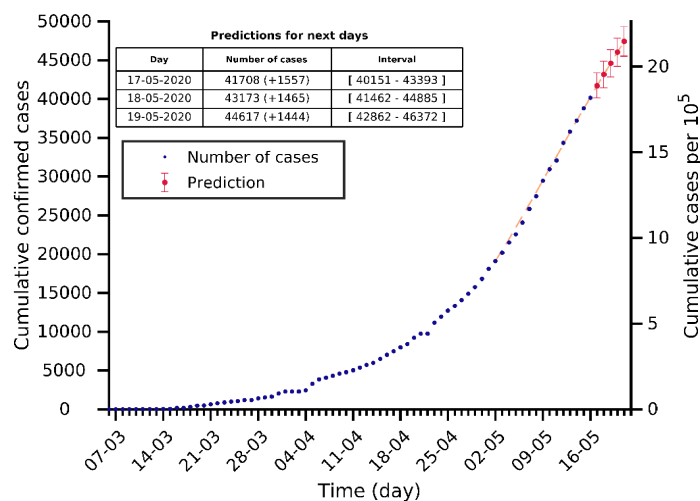
Mexico 16-05-2020. Population: 128.9M. Current cumulated incidence: 37/10⁵



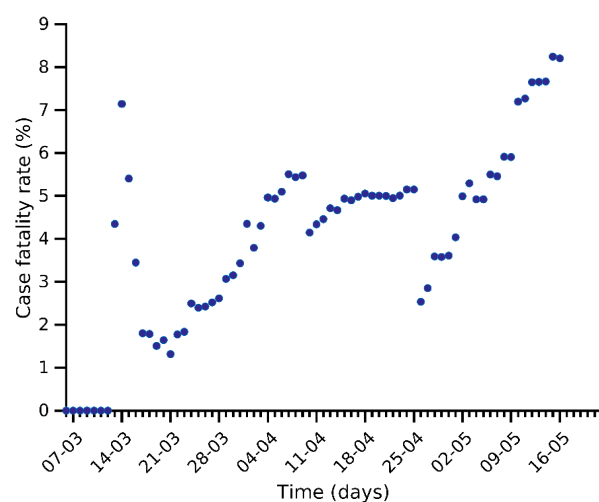
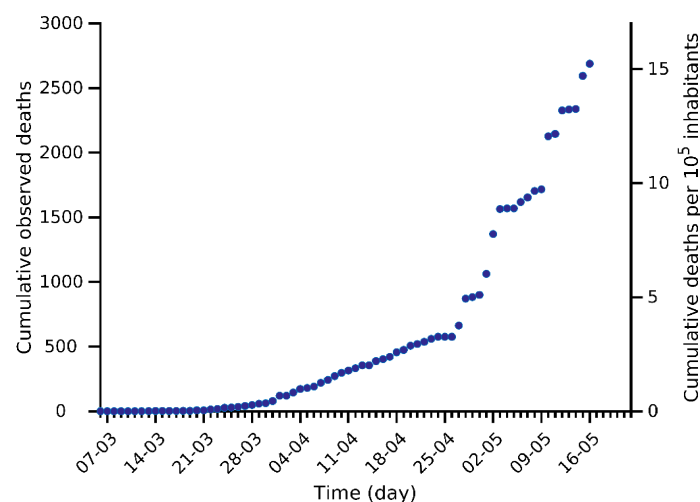
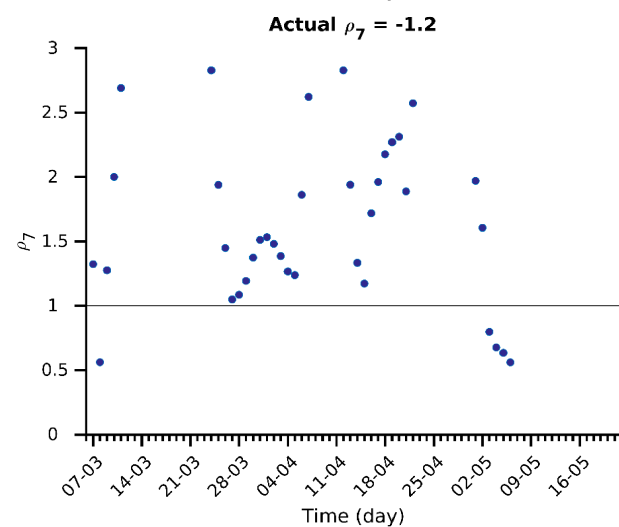
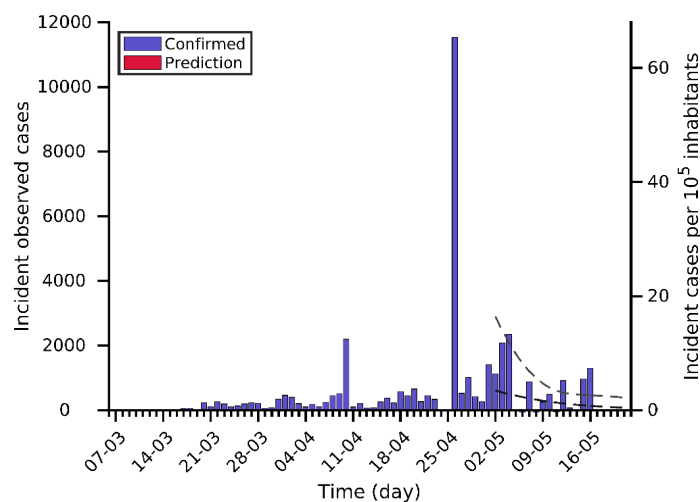
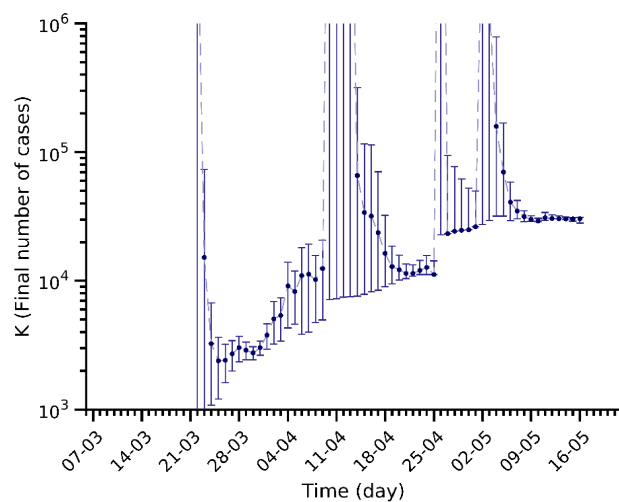
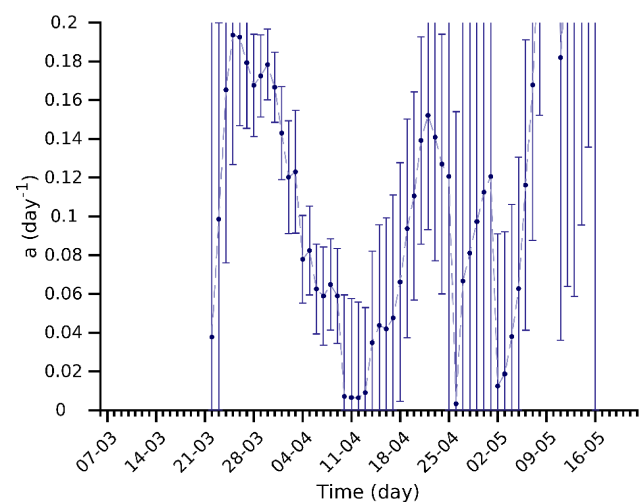
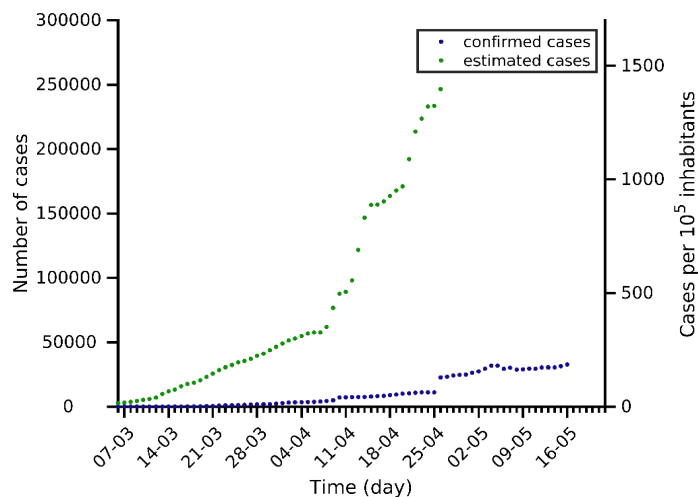
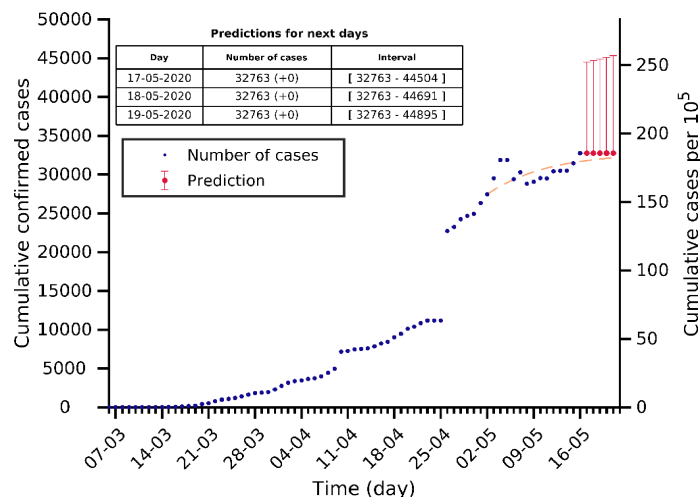
Chile 16-05-2020. Population: 19.1M. Current cumulated incidence: 217/10⁵



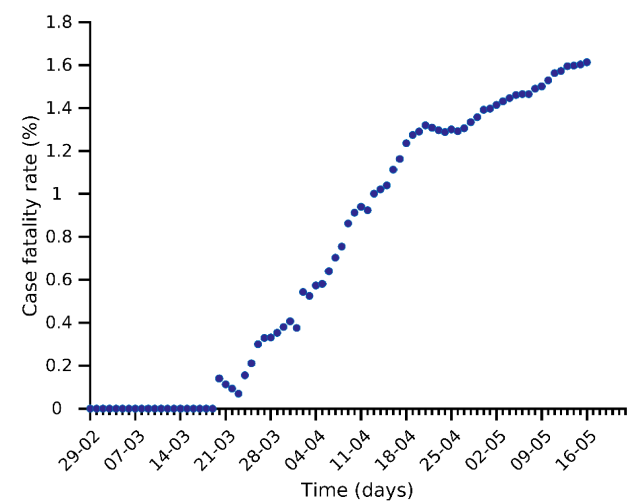
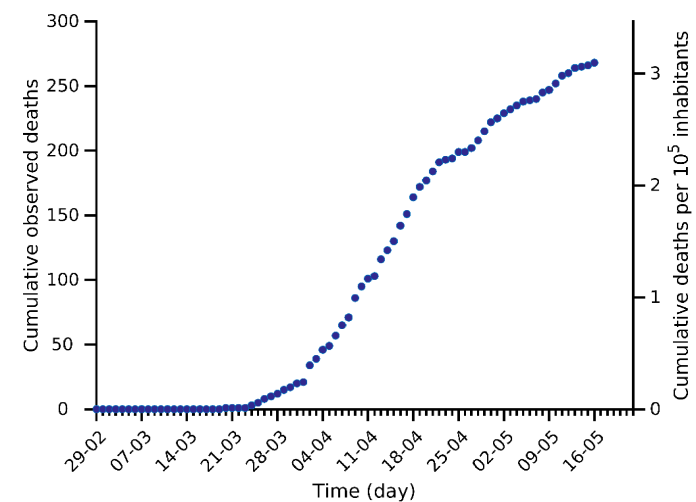
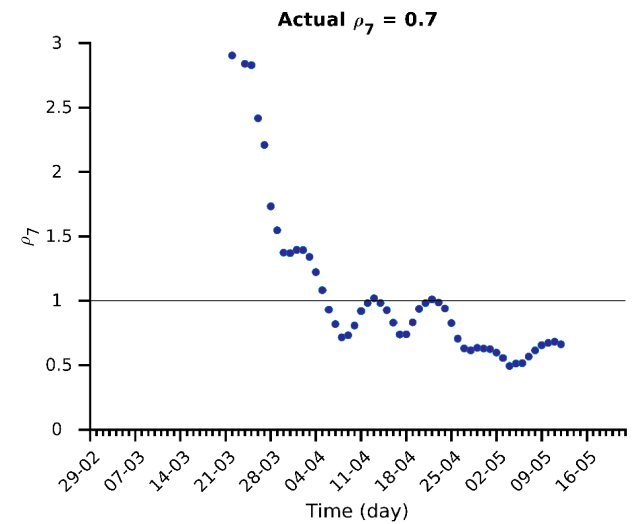
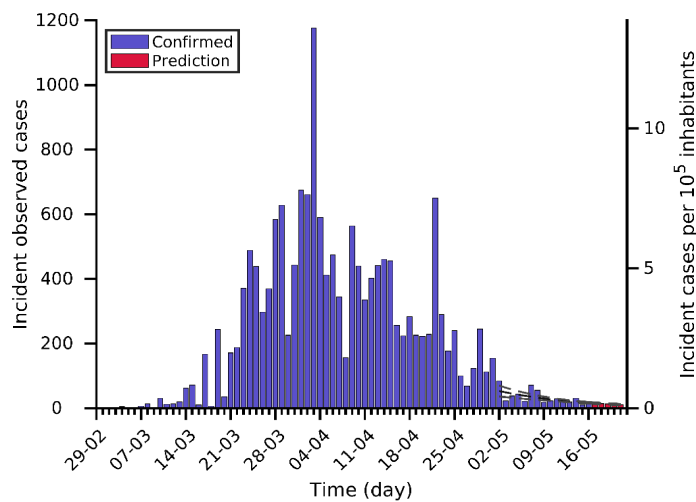
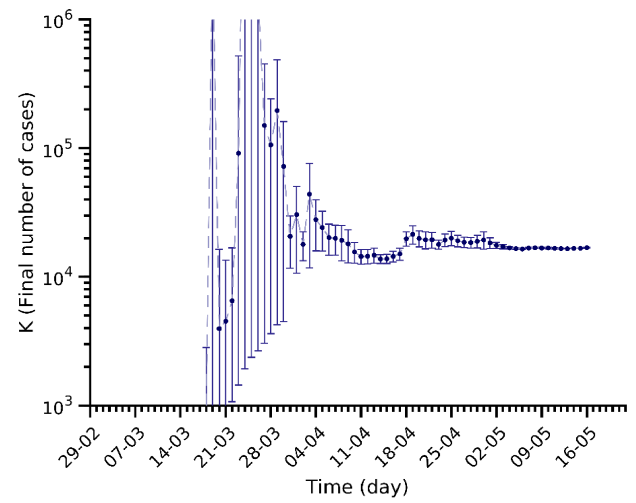
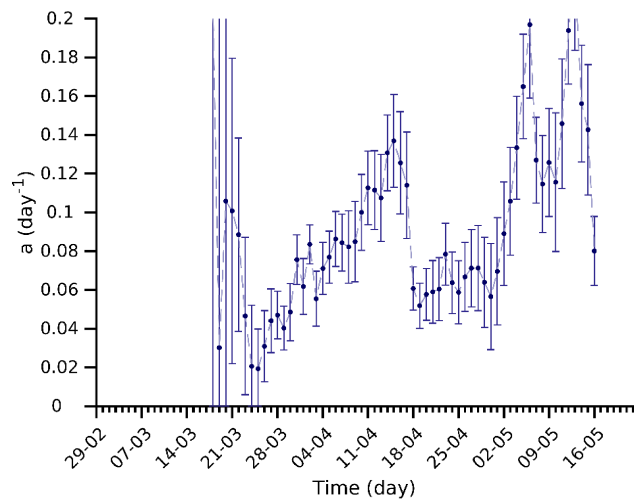
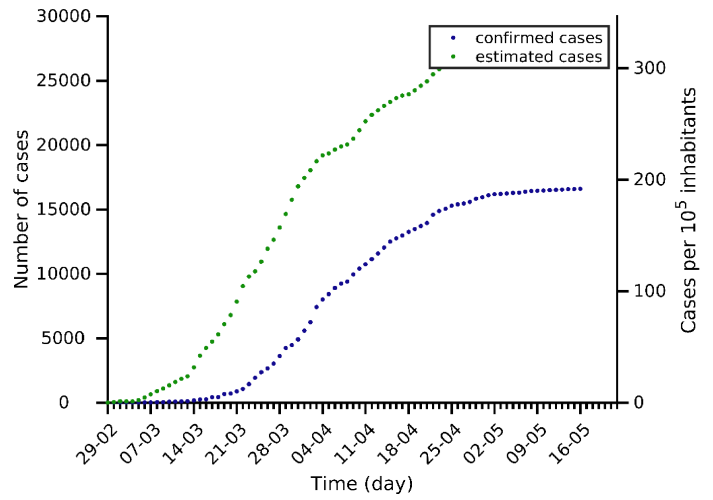
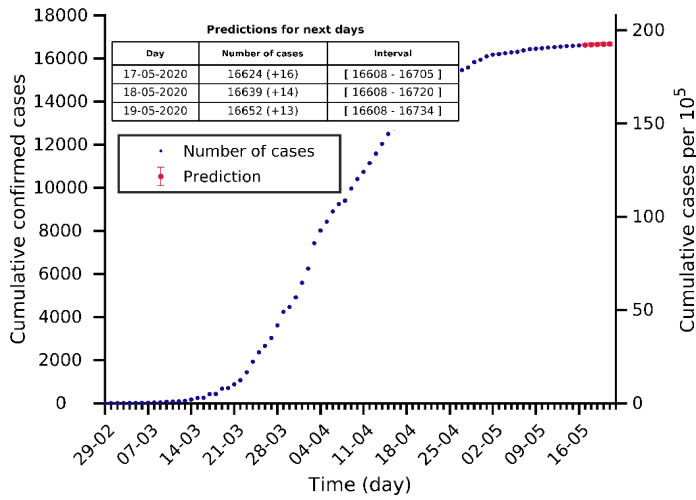
Pakistan 16-05-2020. Population: 220.9M. Current cumulated incidence: 18/10⁵



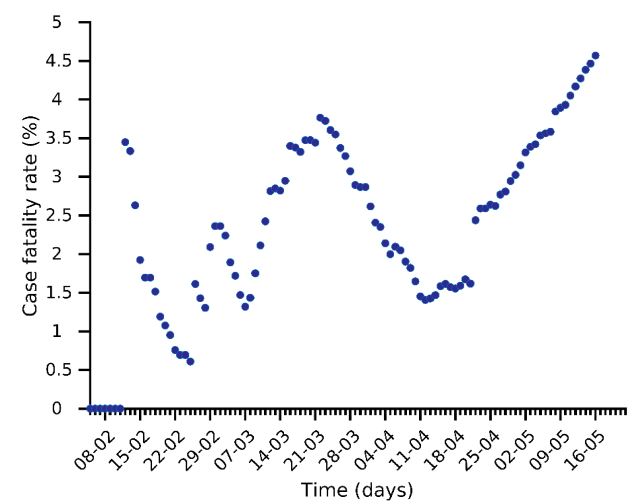
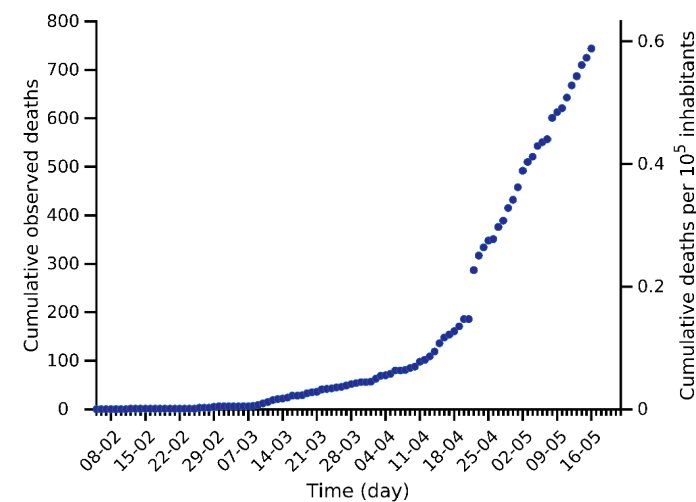
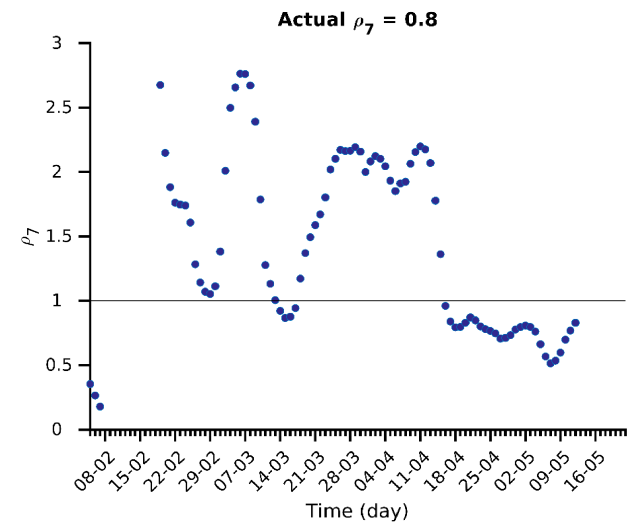
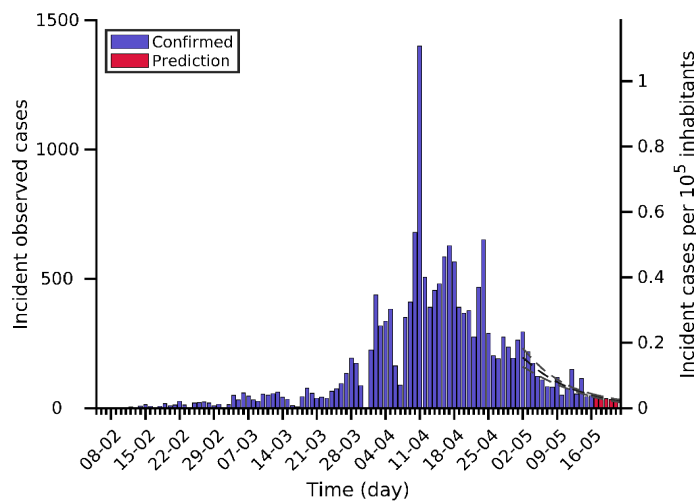
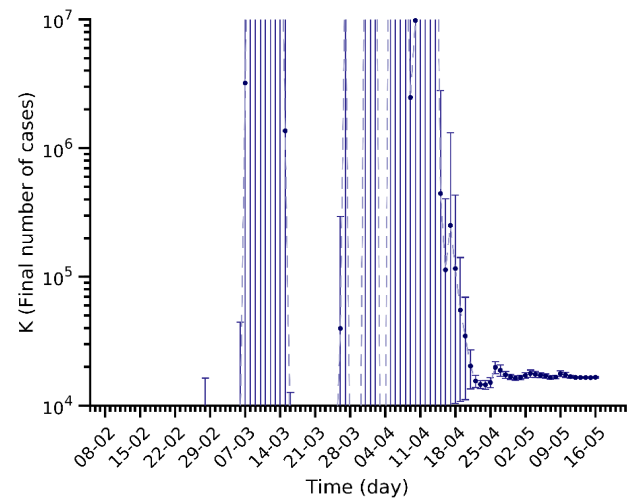
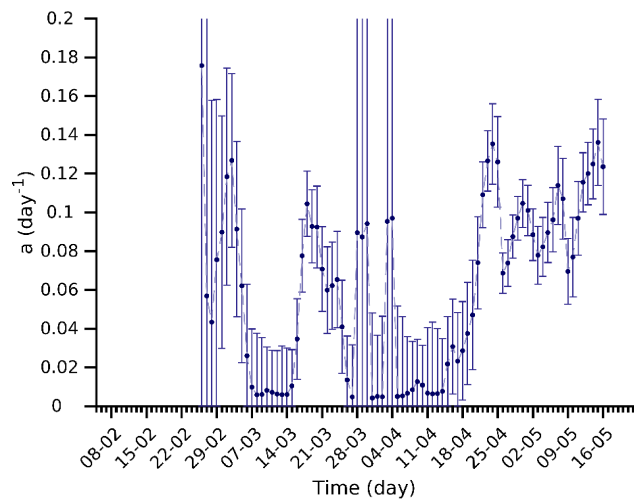
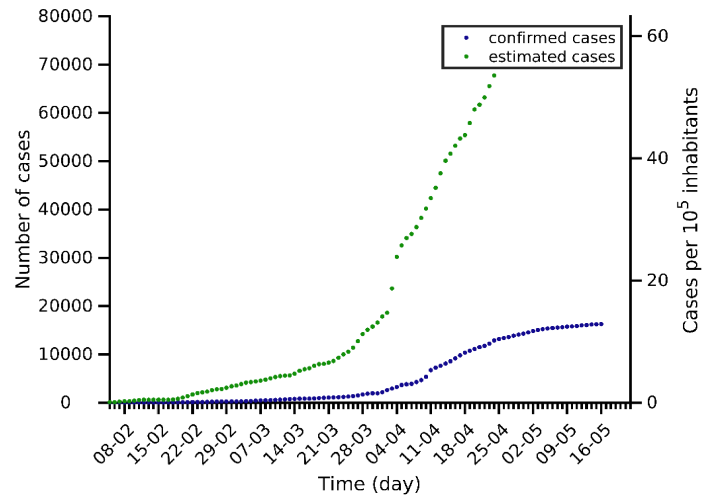
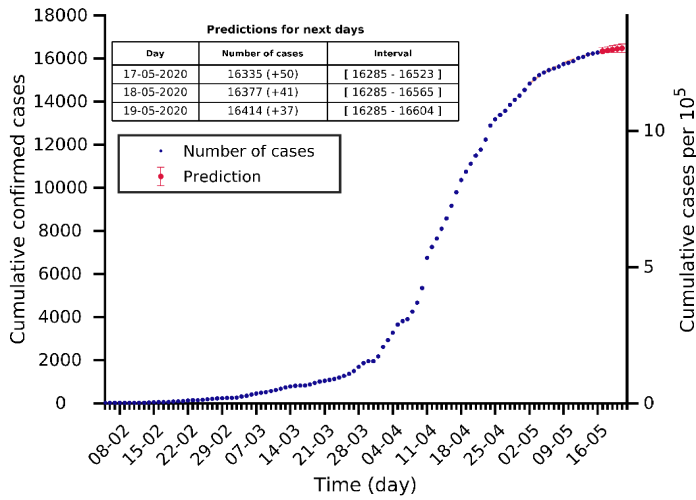
Ecuador 16-05-2020. Population: 17.6M. Current cumulated incidence: 186/10⁵



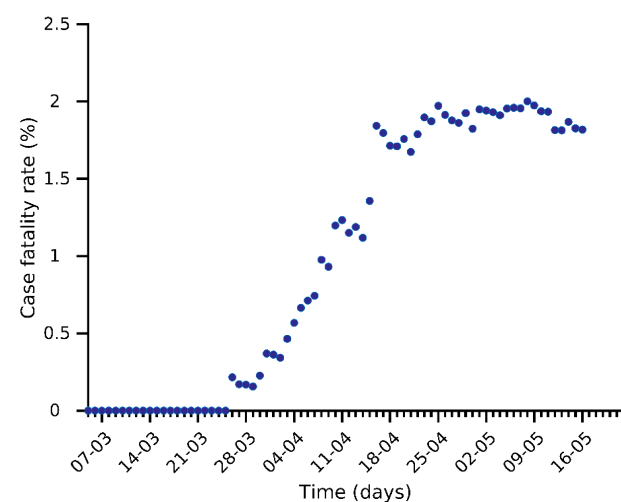
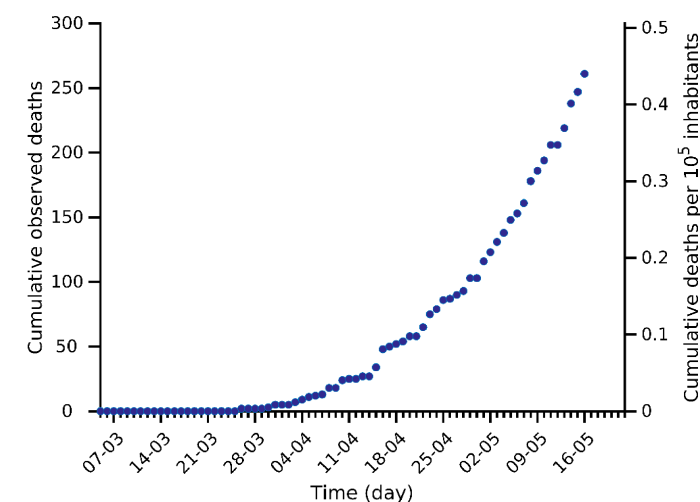
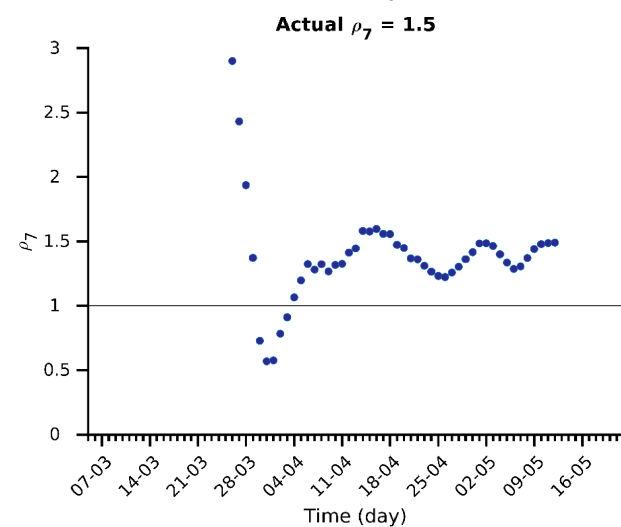
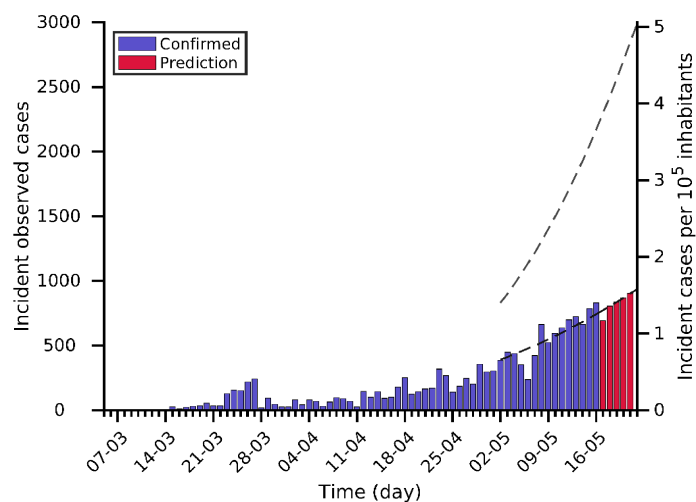
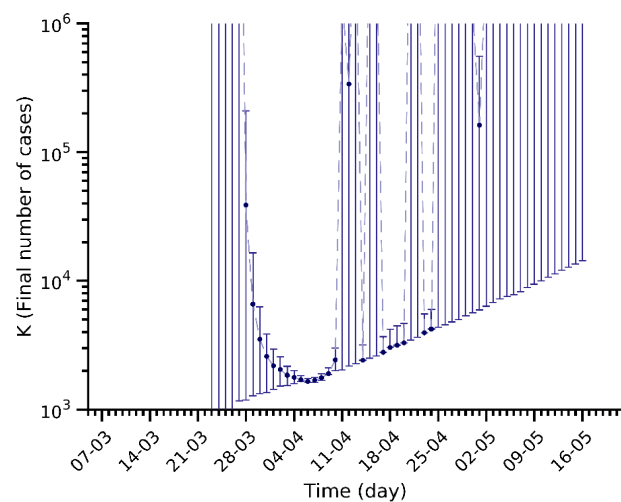
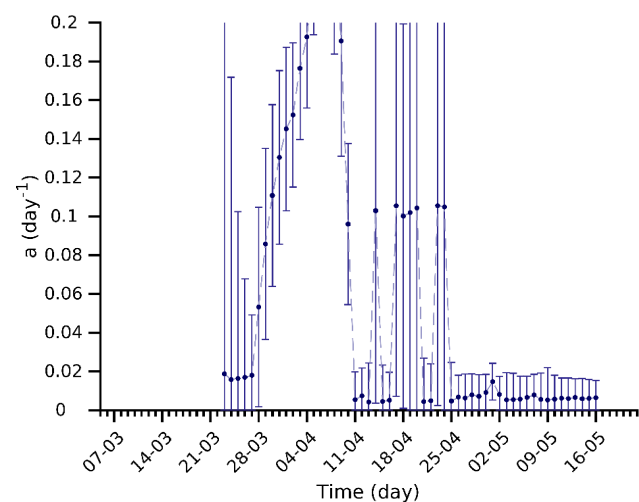
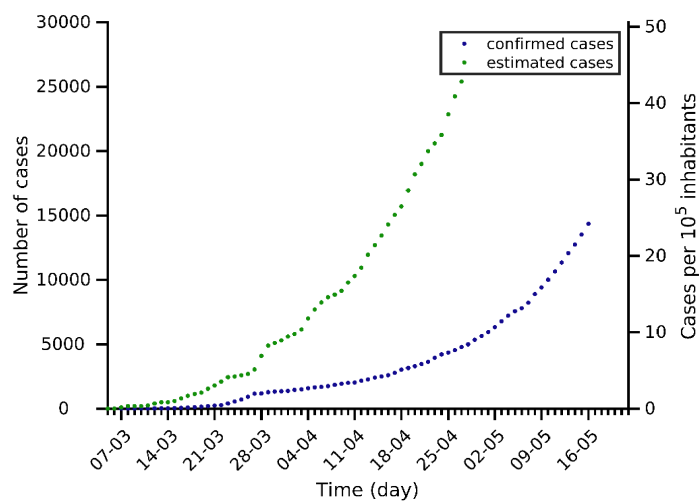
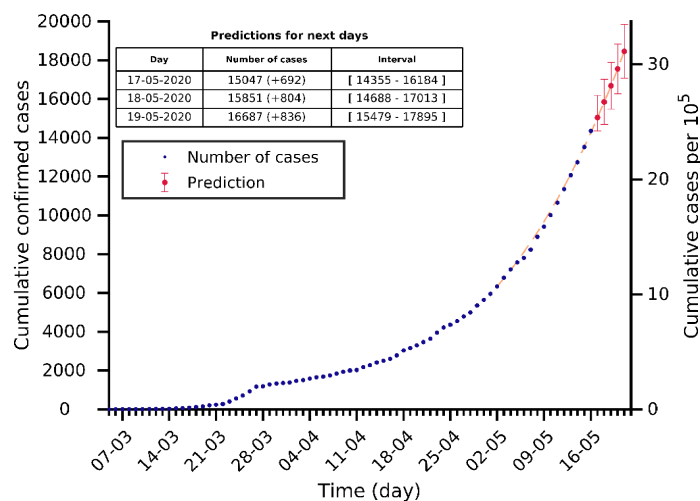
Israel 16-05-2020. Population: 8.7M. Current cumulated incidence: 192/10⁵



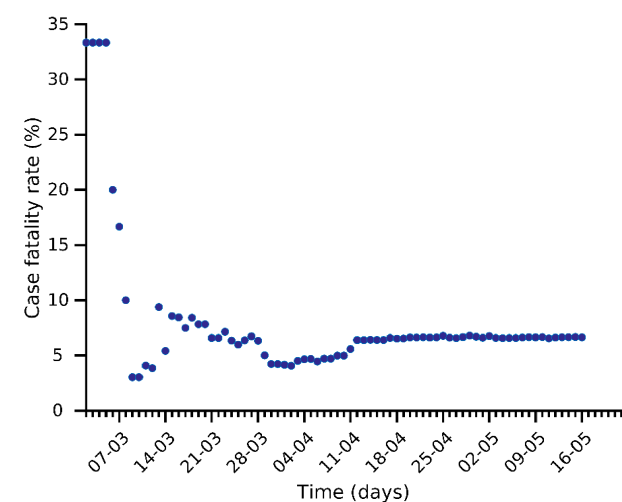
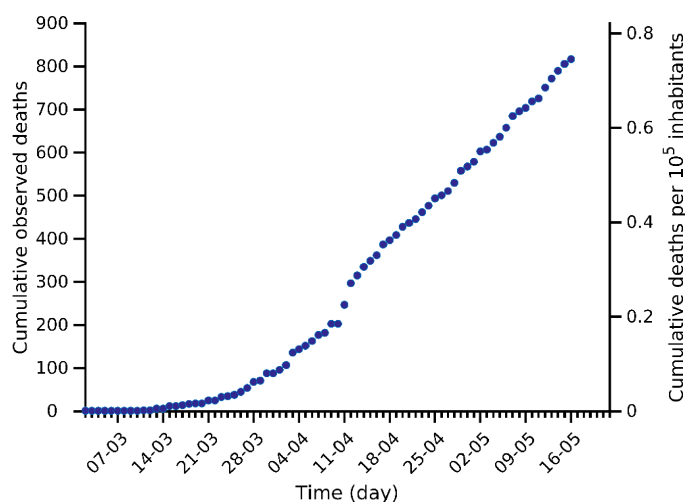
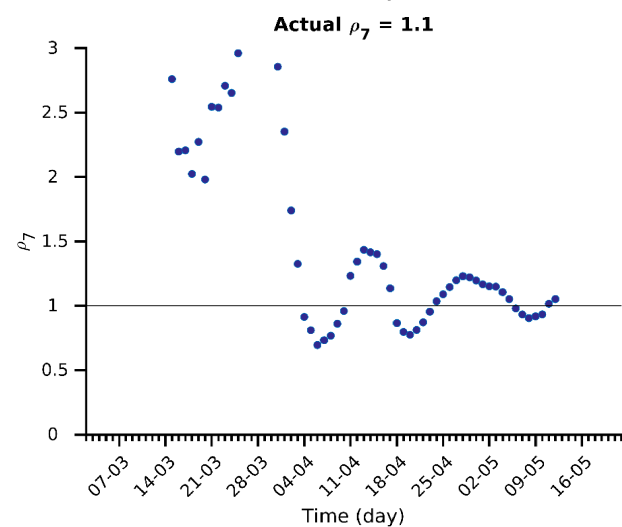
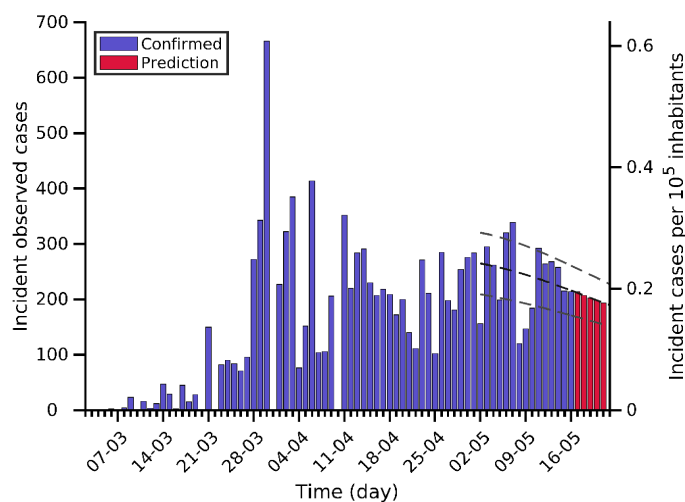
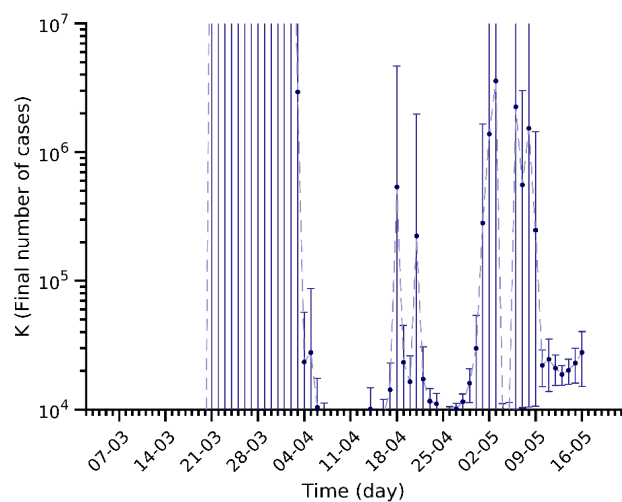
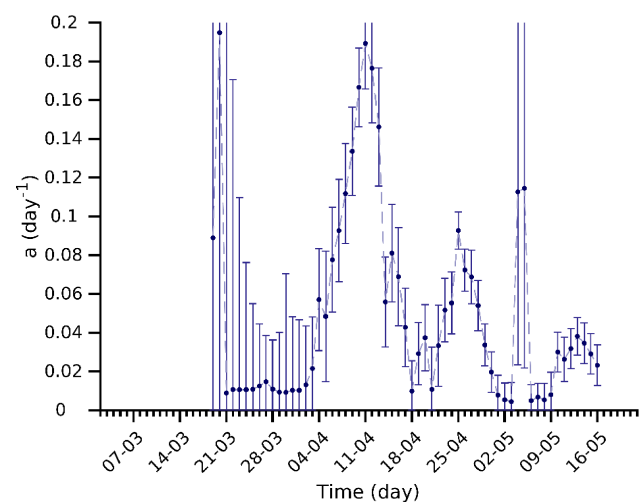
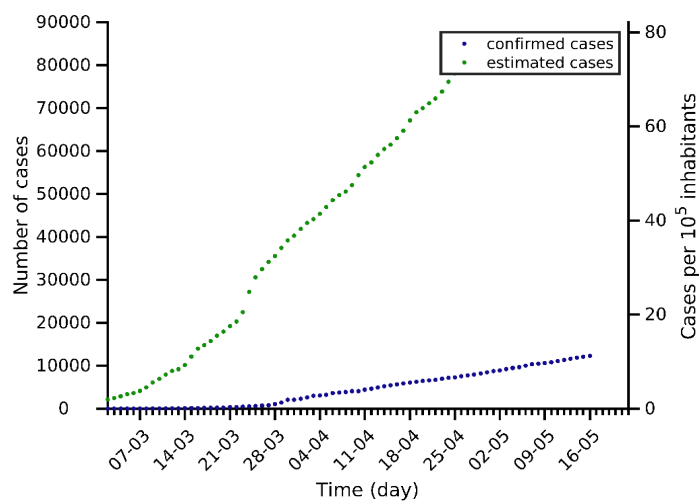
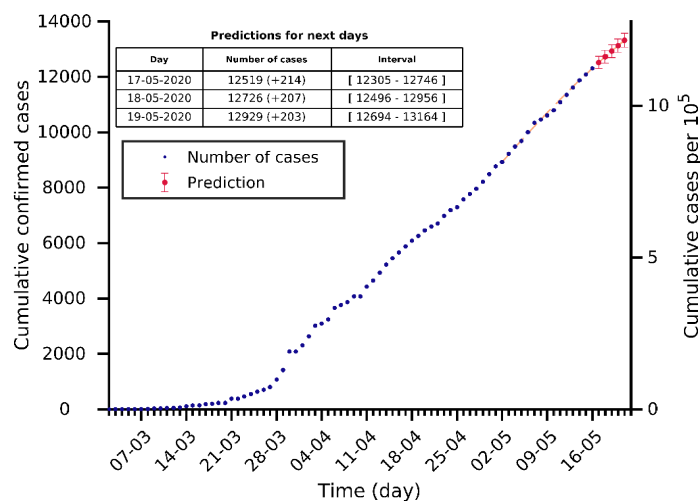
Japan 16-05-2020. Population: 126.5M. Current cumulated incidence: 13/10⁵



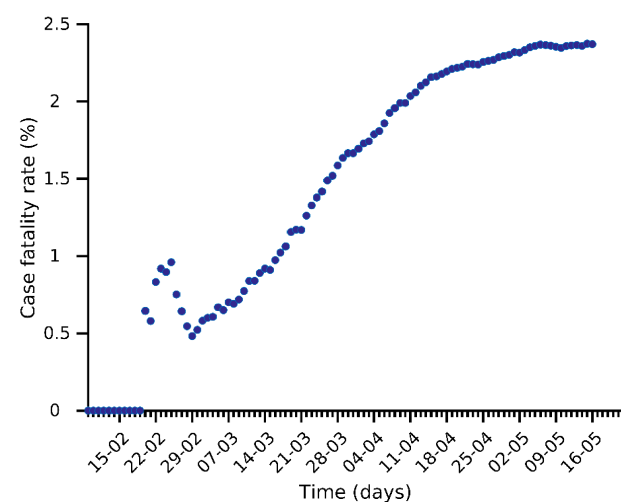
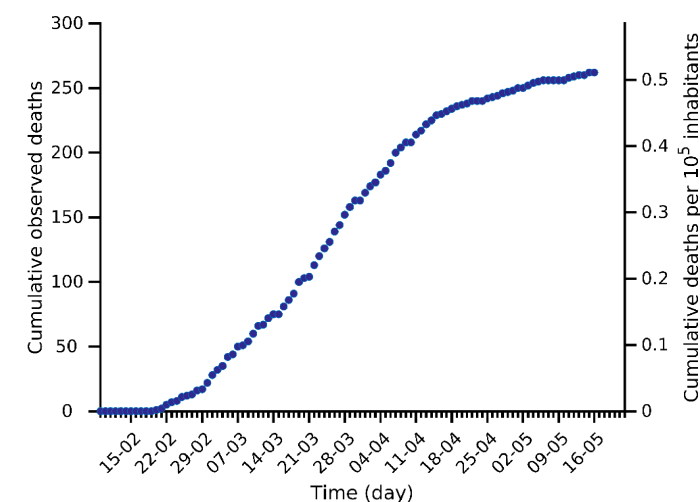
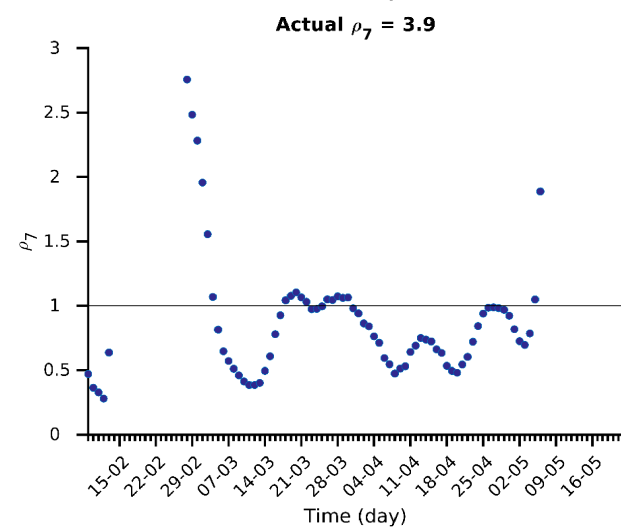
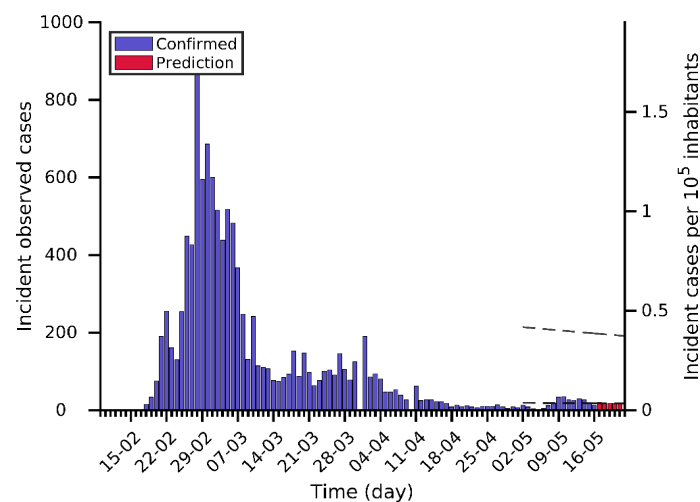
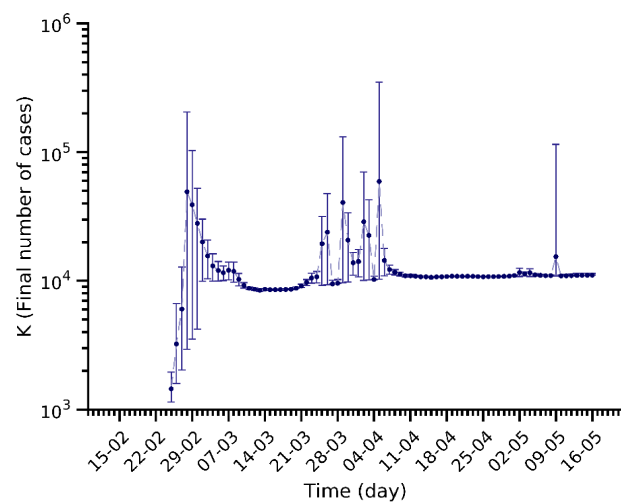
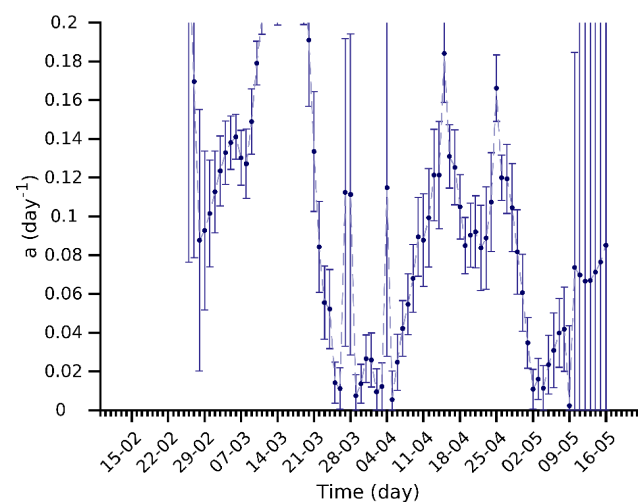
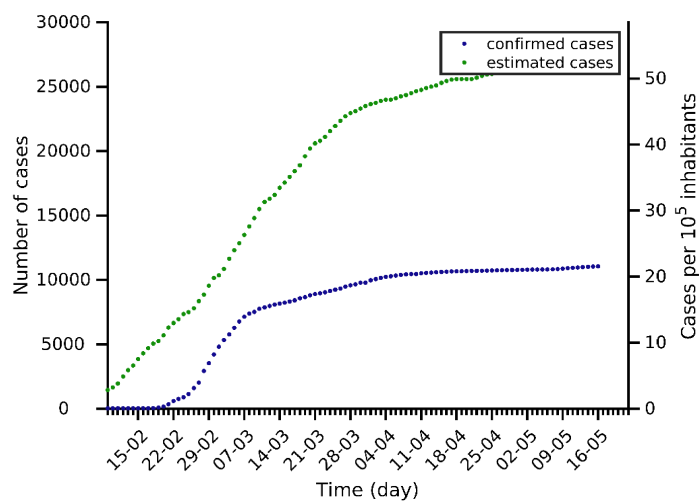
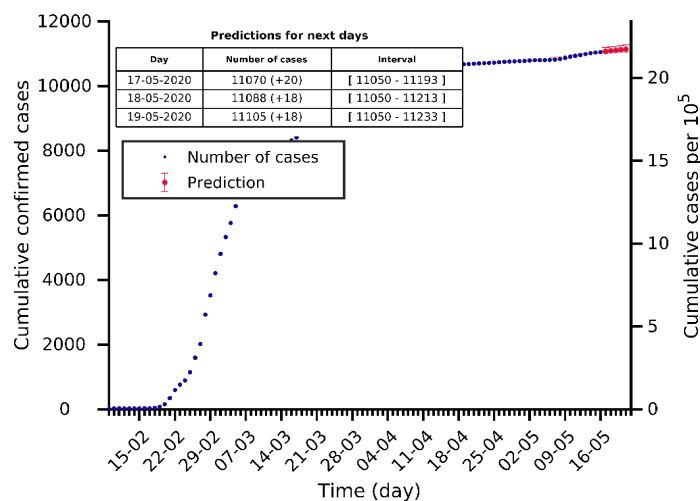
South Africa 16-05-2020. Population: 59.3M. Current cumulated incidence: 24/10⁵



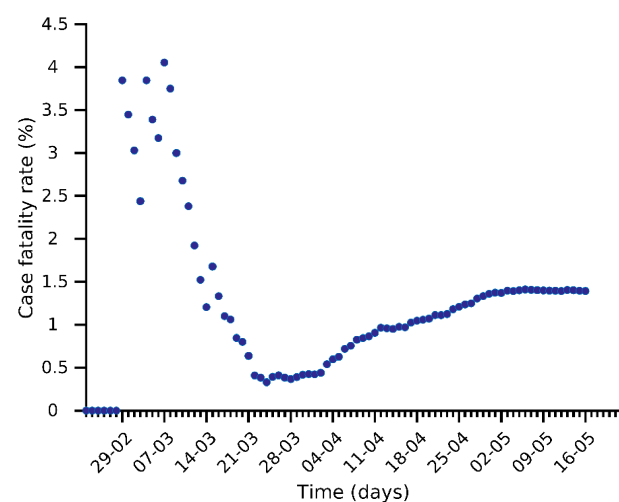
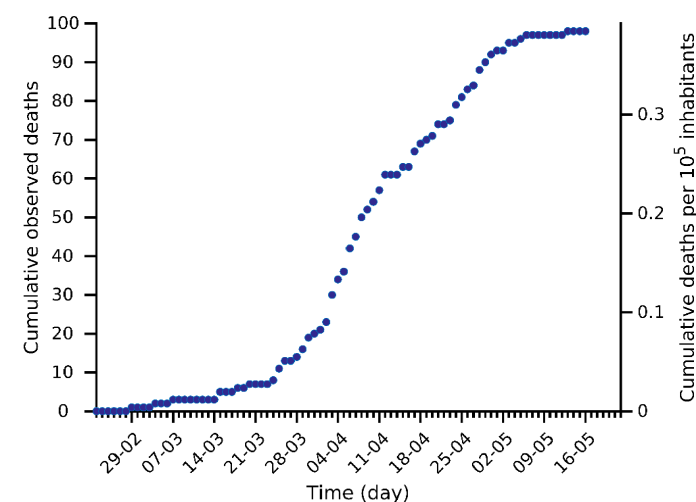
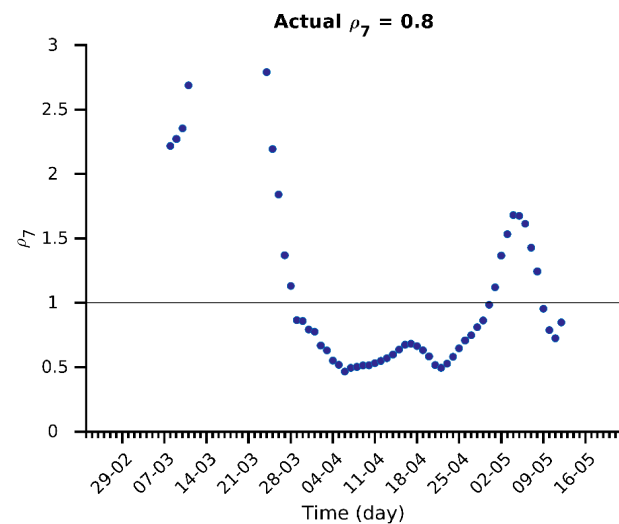
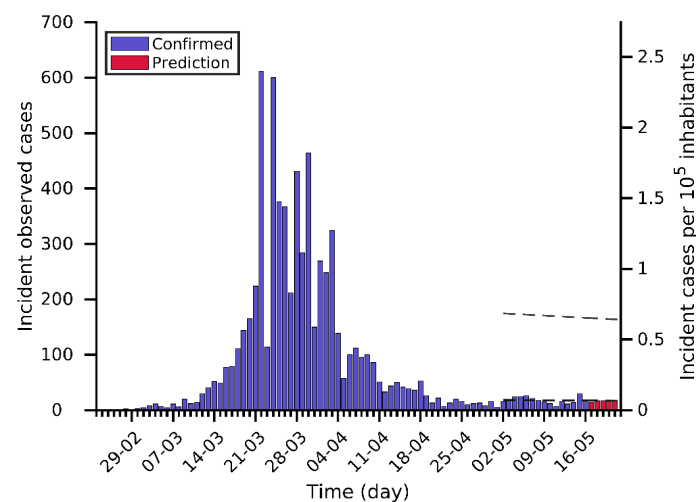
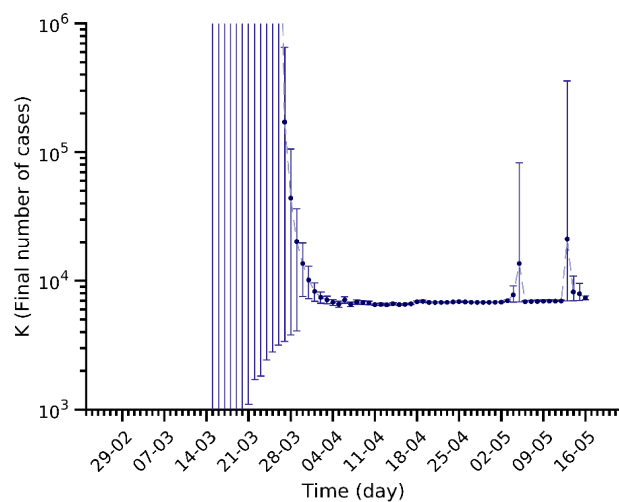
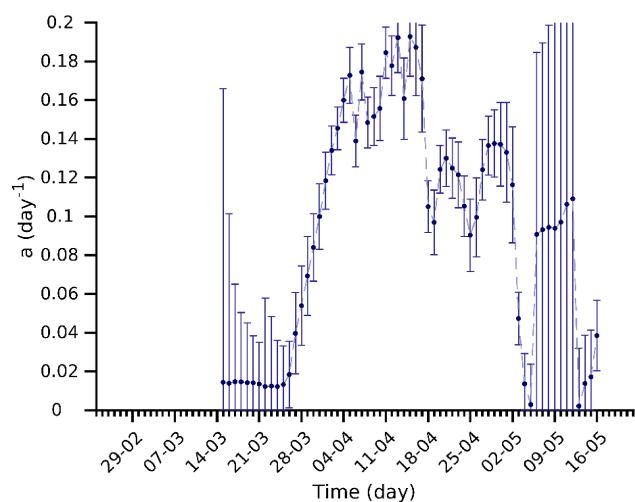
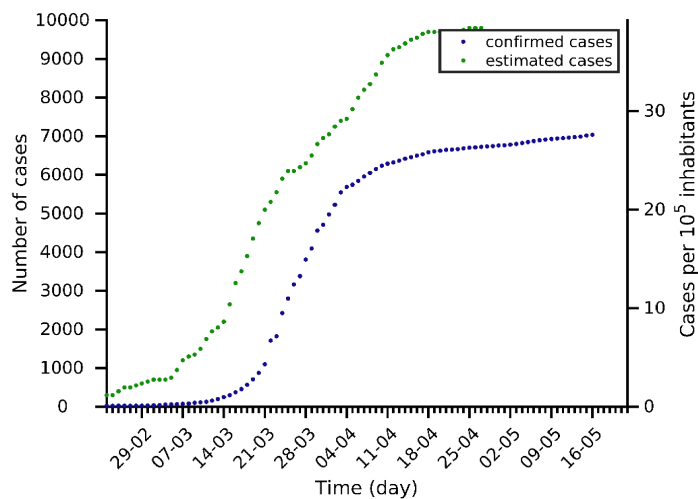
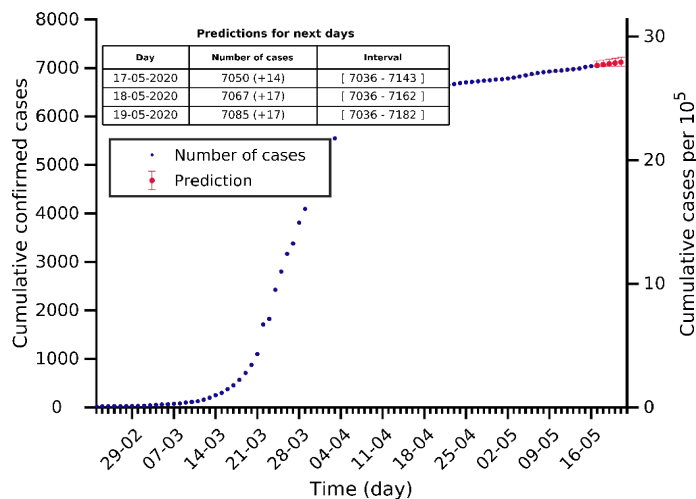
Philippines 16-05-2020. Population: 109.6M. Current cumulated incidence: 11/10⁵



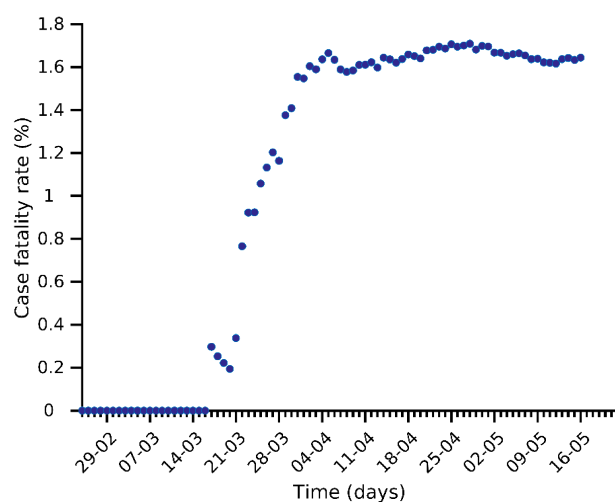
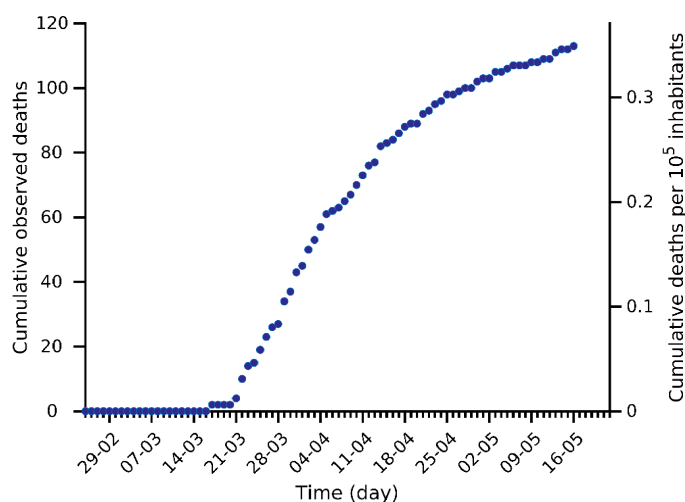
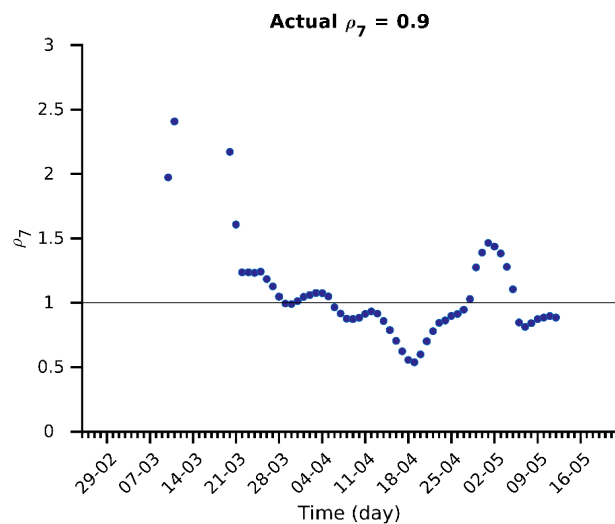
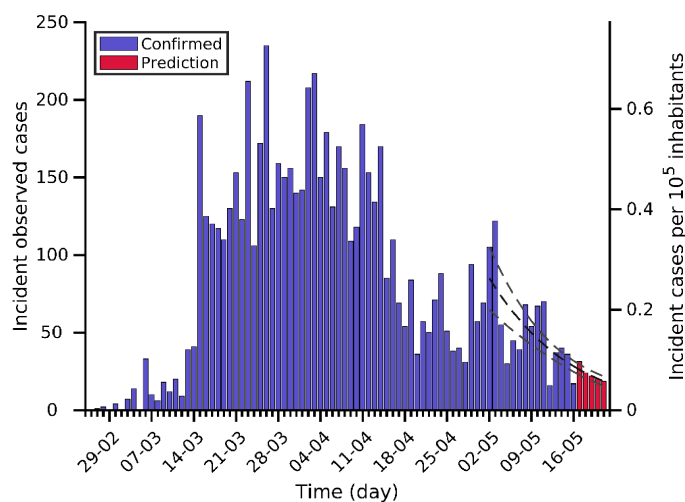
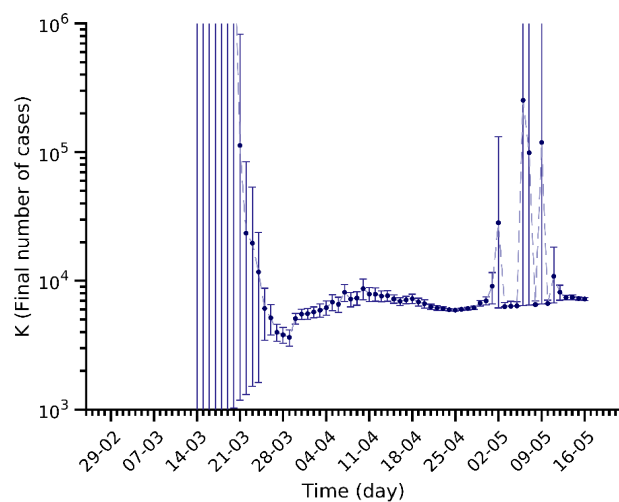
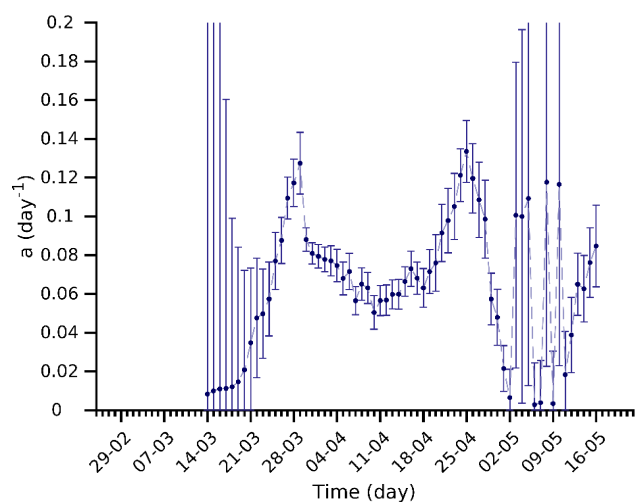
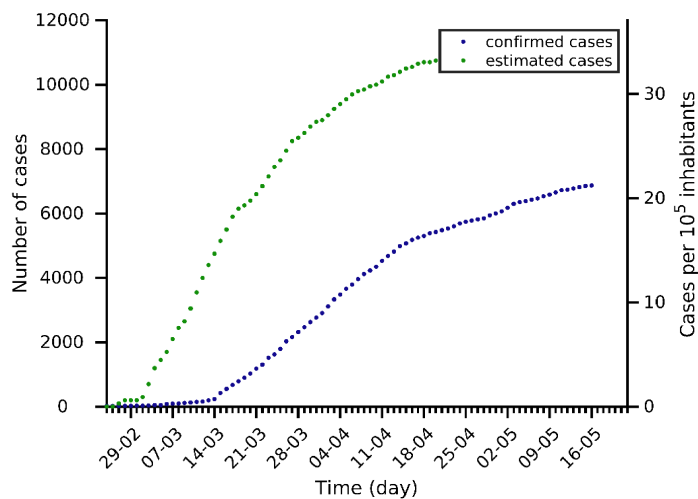
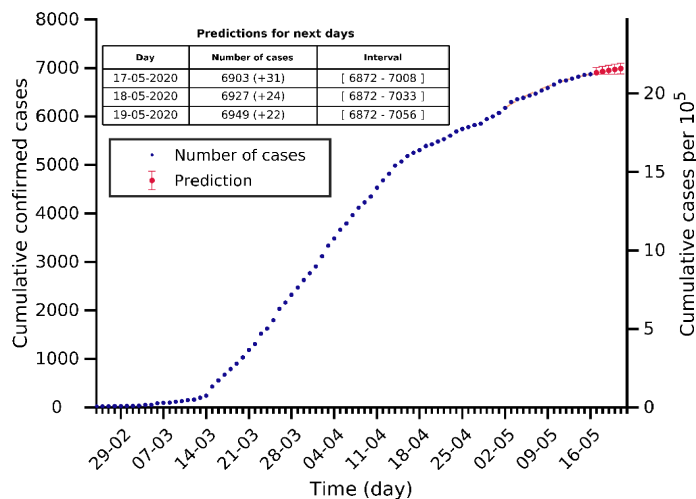
South Korea 16-05-2020. Population: 51.3M. Current cumulated incidence: 22/10⁵



Australia 16-05-2020. Population: 25.5M. Current cumulated incidence: 28/10⁵



Malaysia 16-05-2020. Population: 32.4M. Current cumulated incidence: 21/10⁵

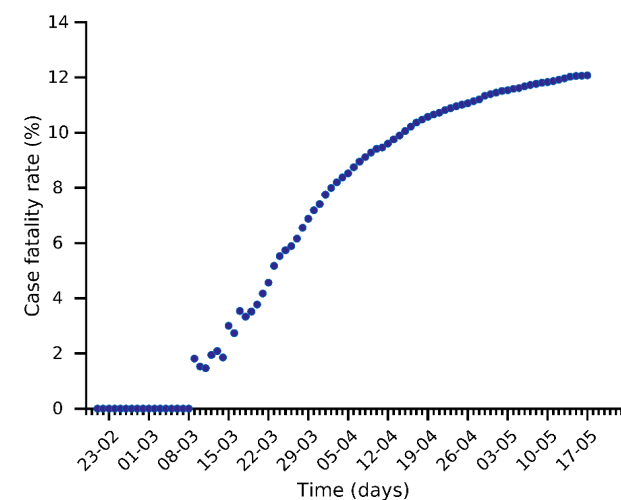
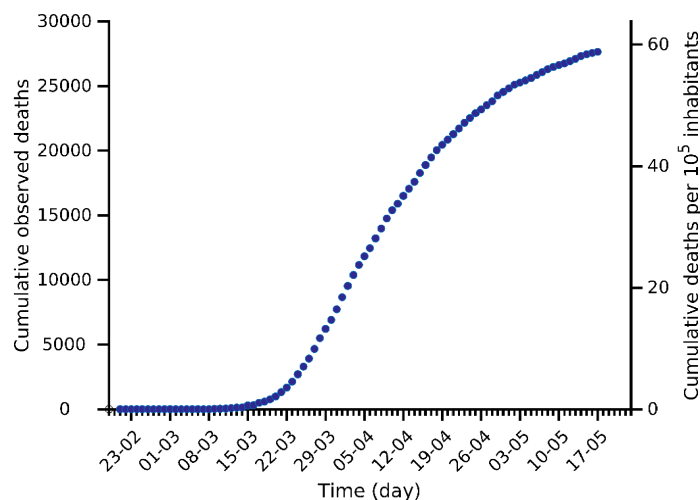
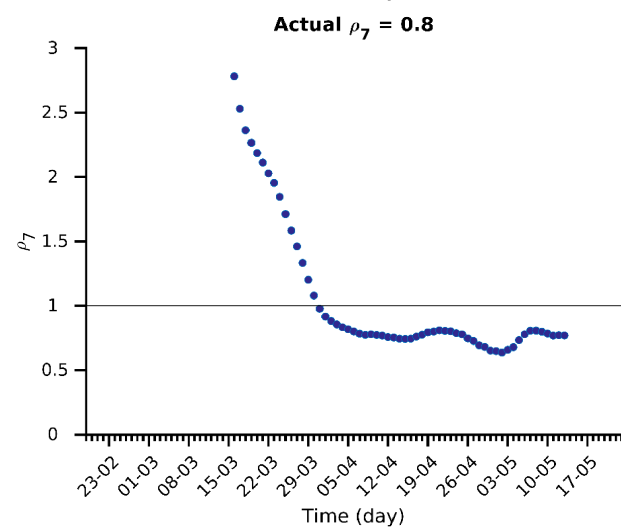
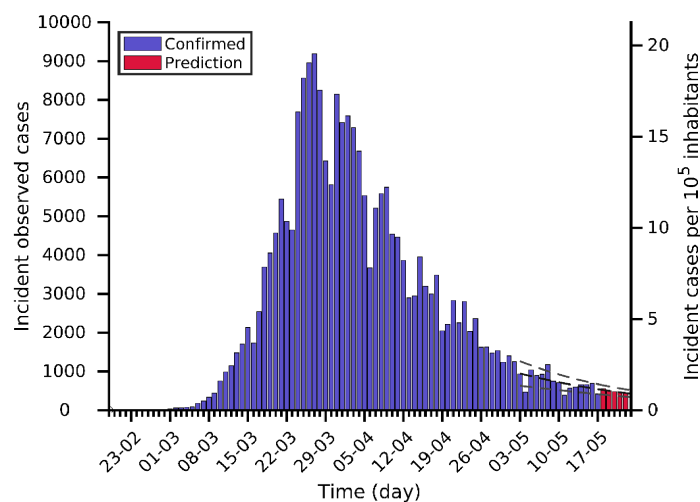
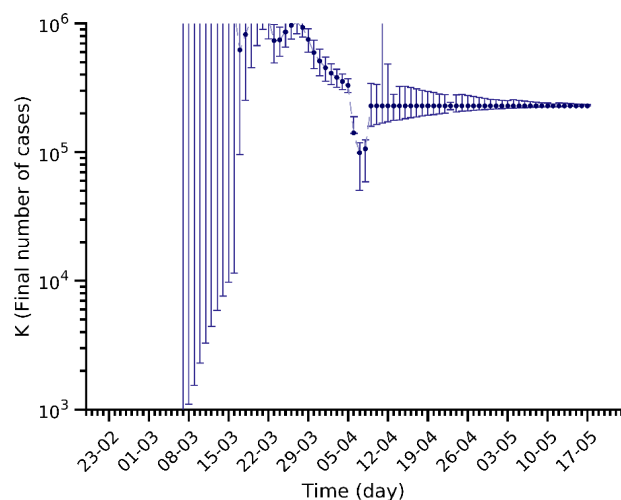
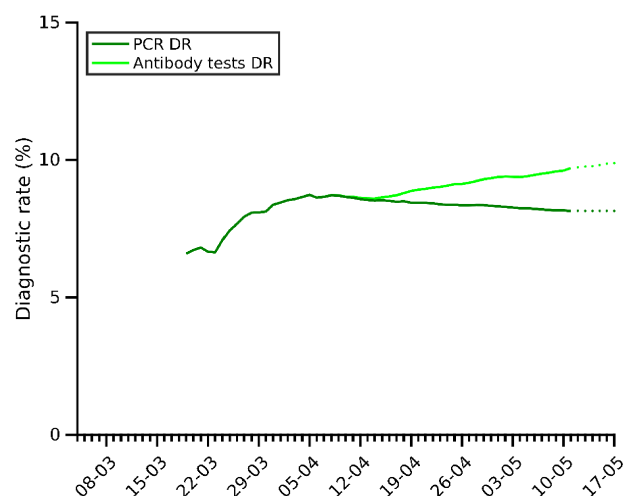
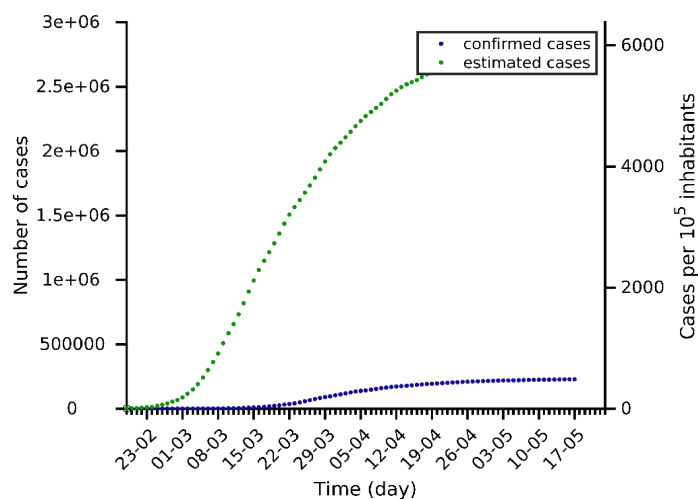
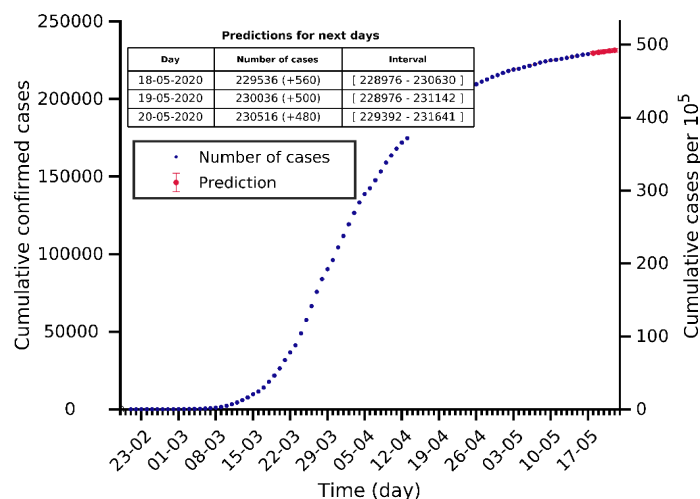


(3) Analysis and prediction of COVID-19 for Spain and its autonomous communities

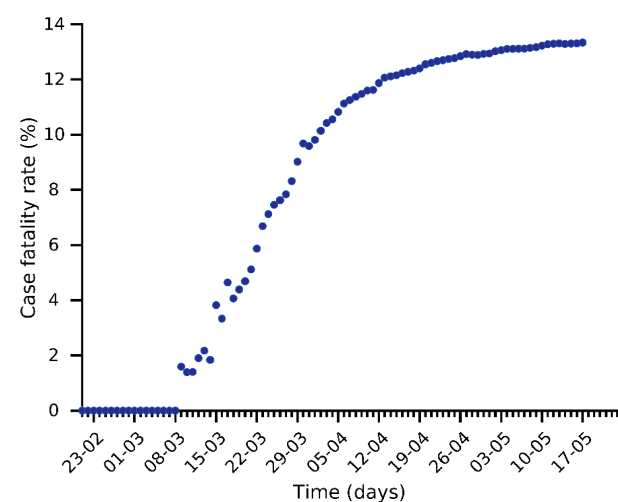
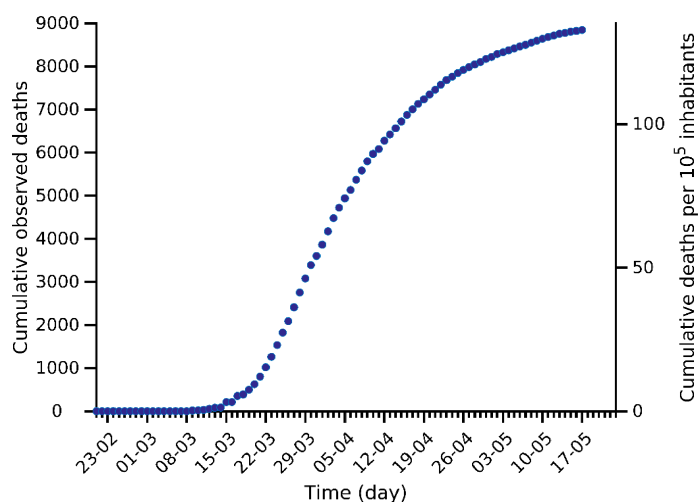
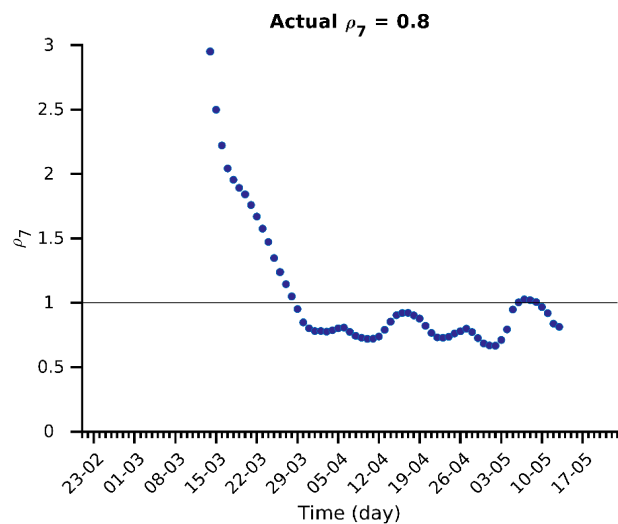
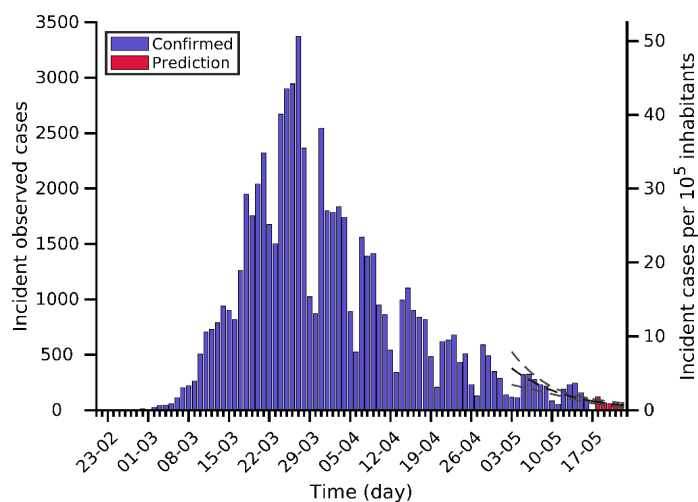
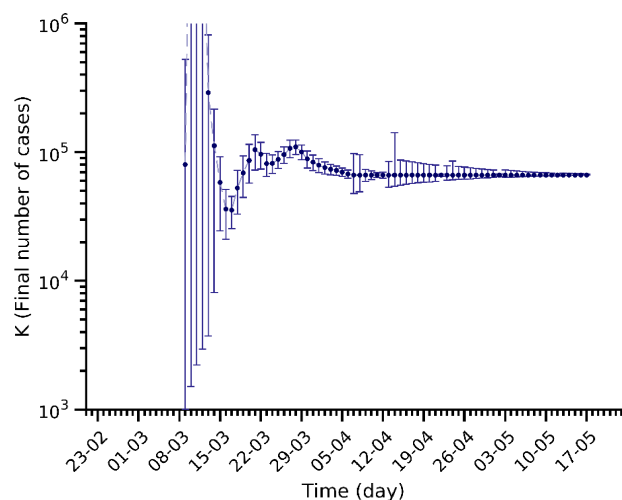
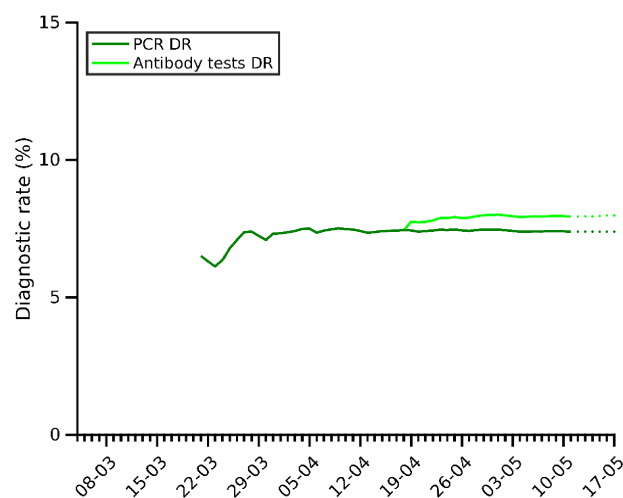
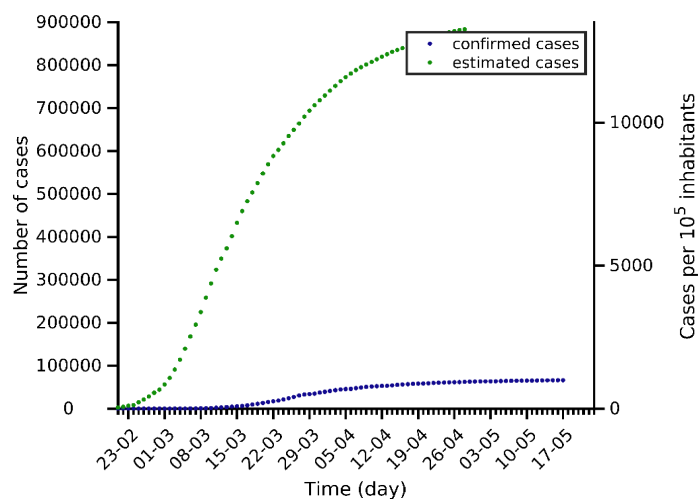
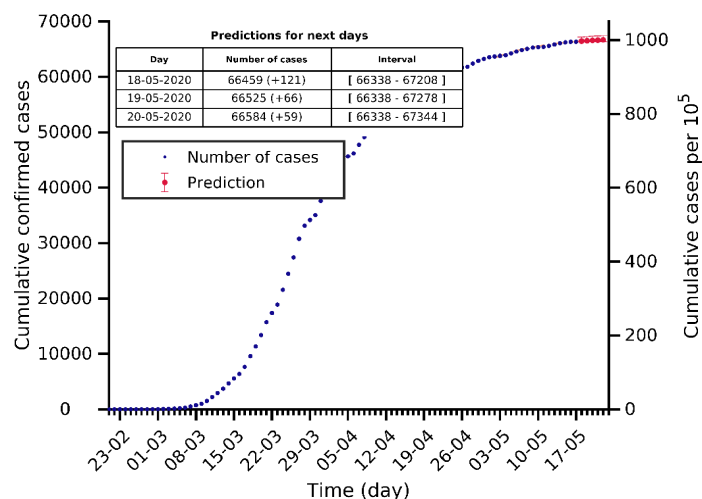
**WARNING: Data from Catalunya and Spain
are provisional, pending on the indication to
locate 2715 old cases.**

Data obtained from <https://github.com/datadista/datasets/tree/master/COVID%2019> and
<https://covid19.isciii.es/>

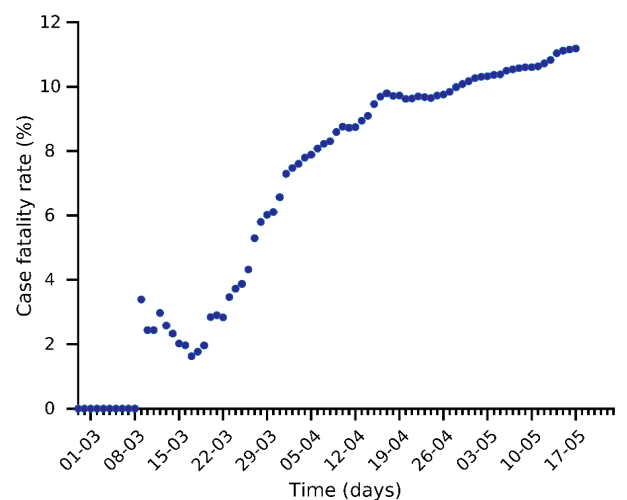
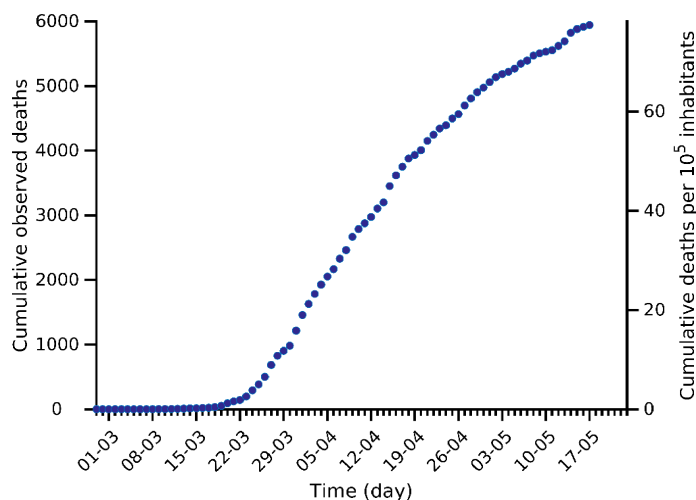
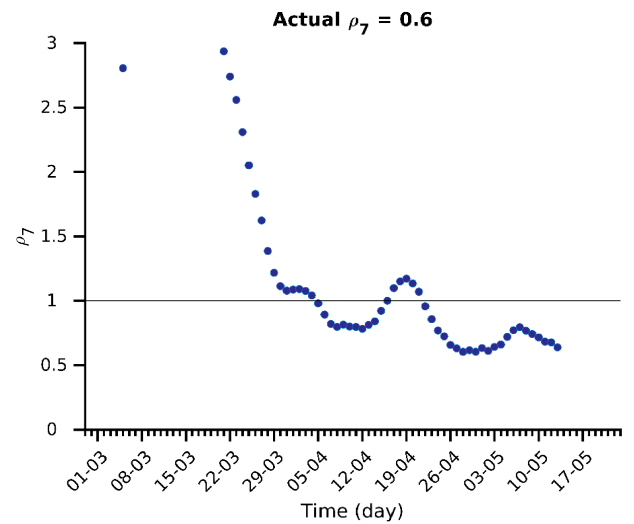
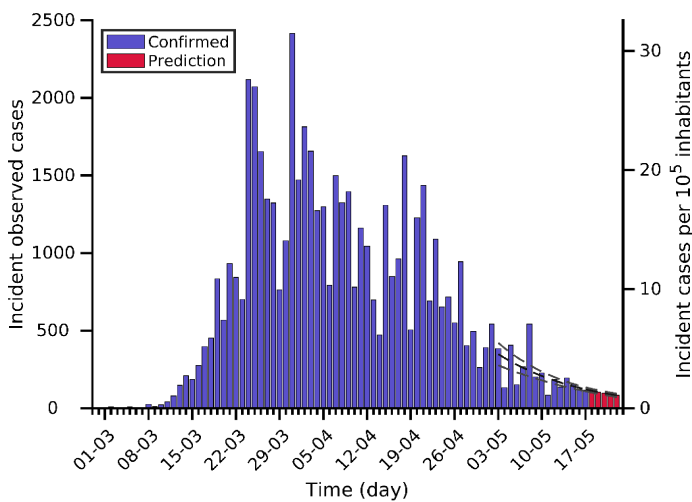
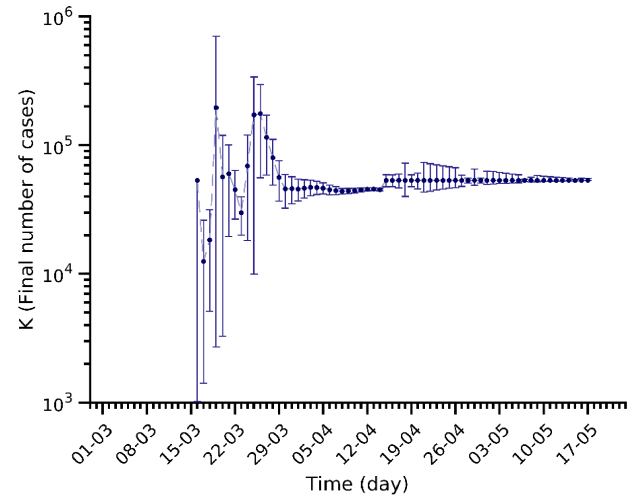
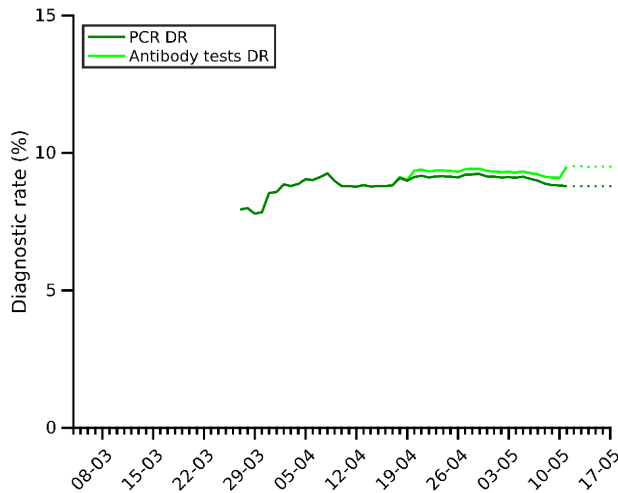
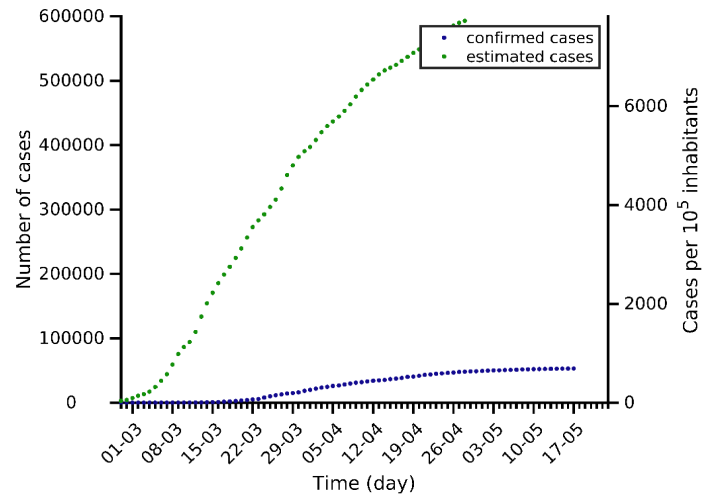
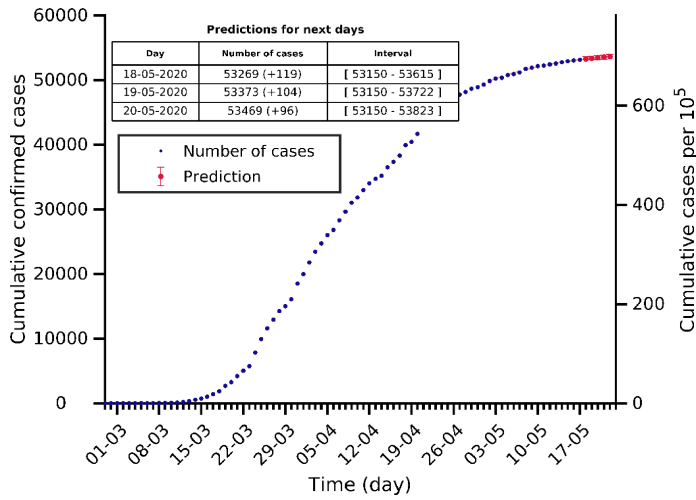
Spain 17-05-2020. Population: 47.0M. Current cumulated incidence: 487/10⁵



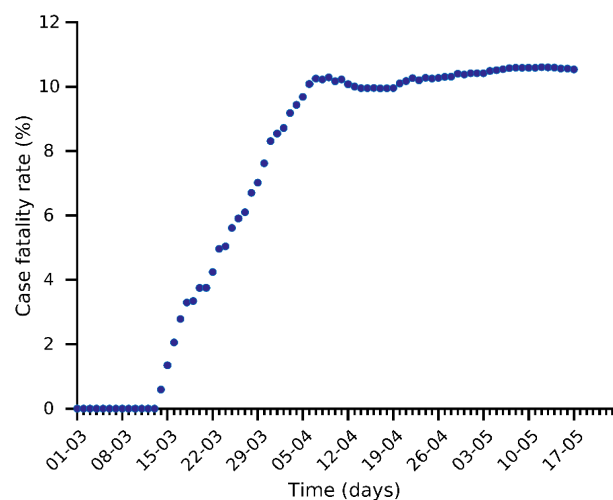
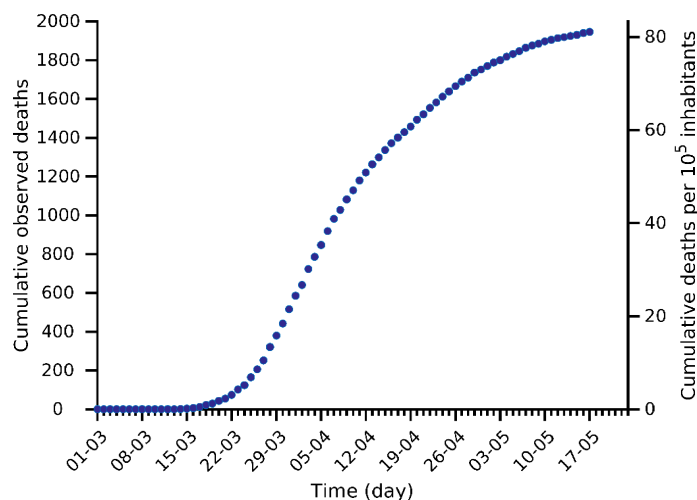
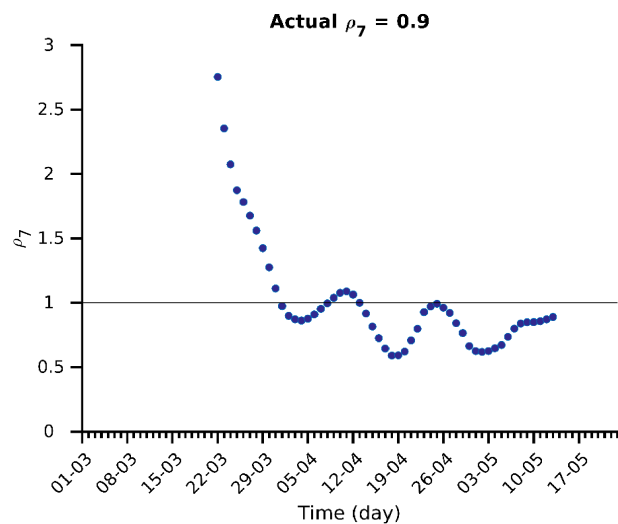
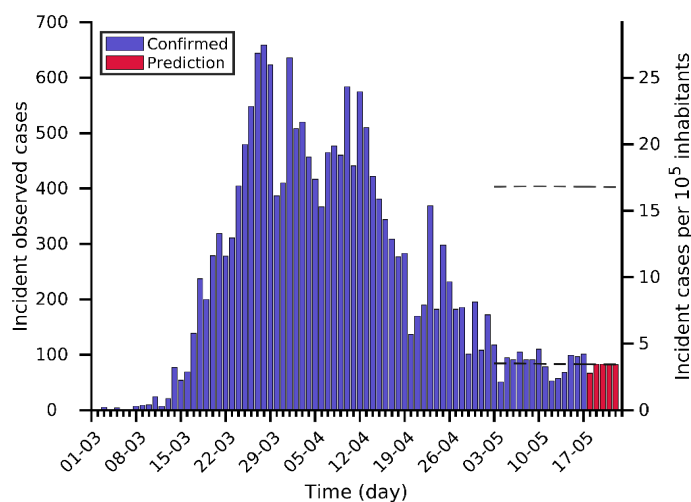
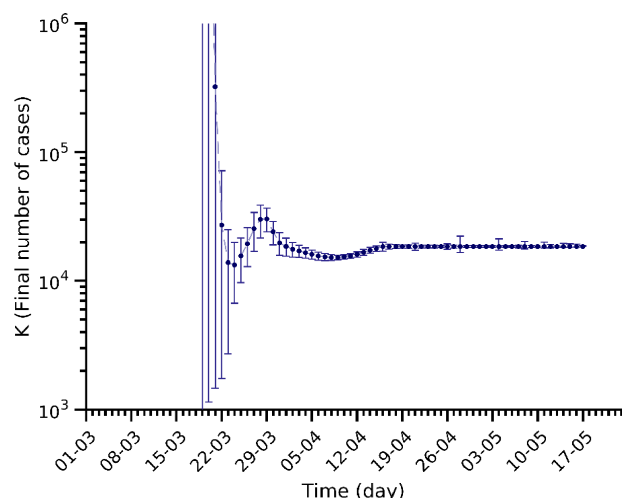
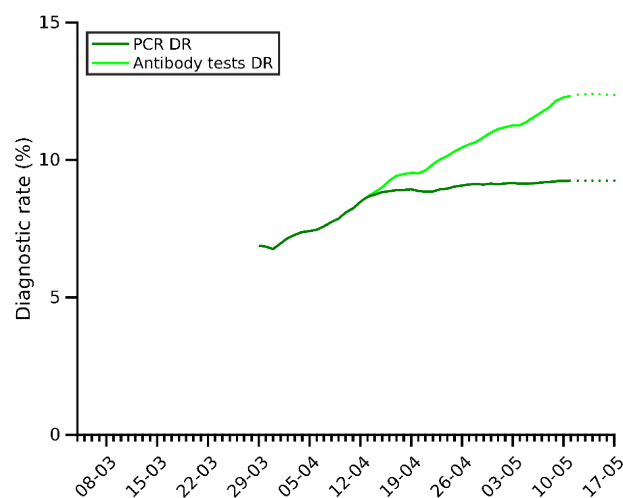
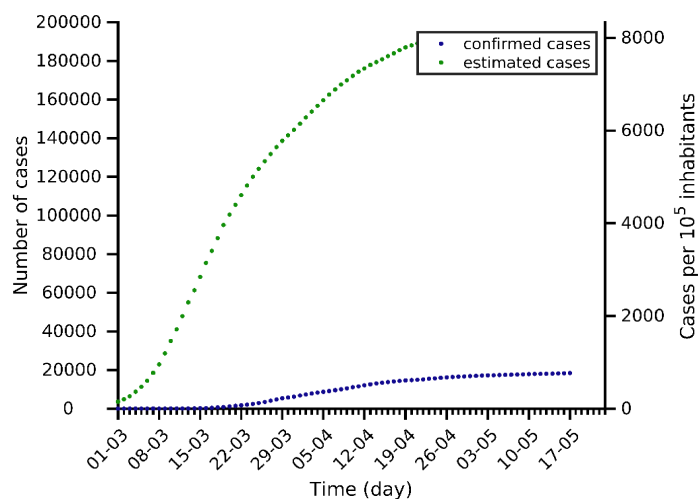
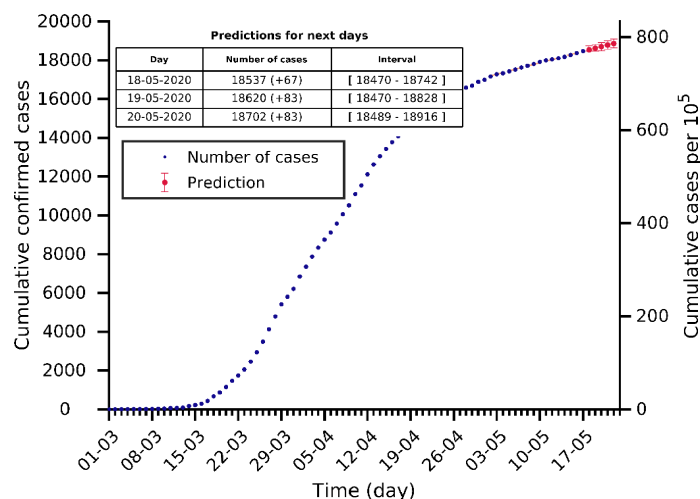
Madrid 17-05-2020. Population: 6.7M. Current cumulated incidence: 996/10⁵



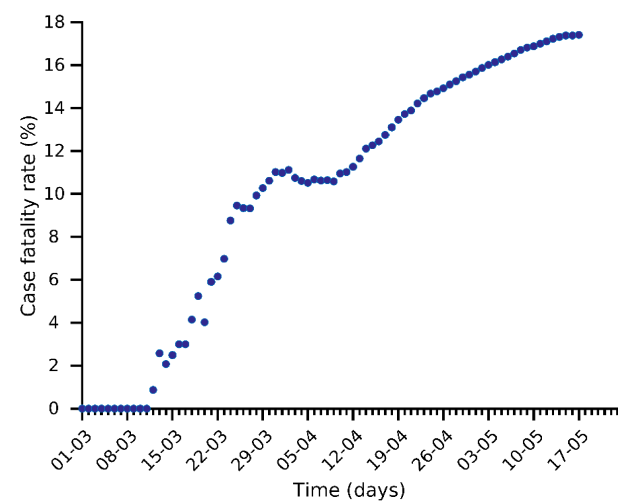
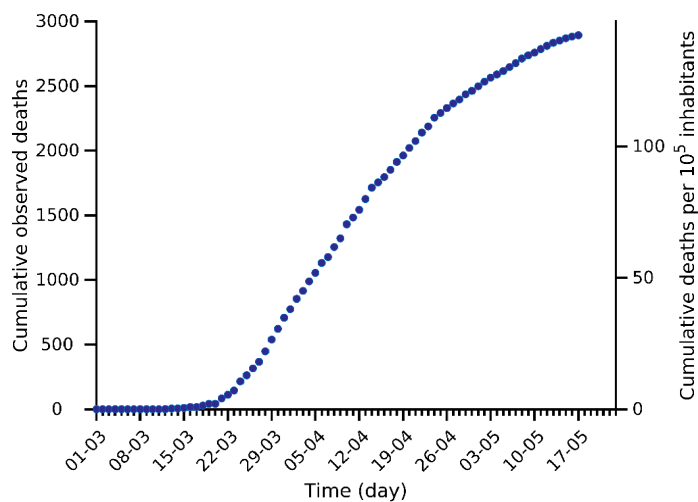
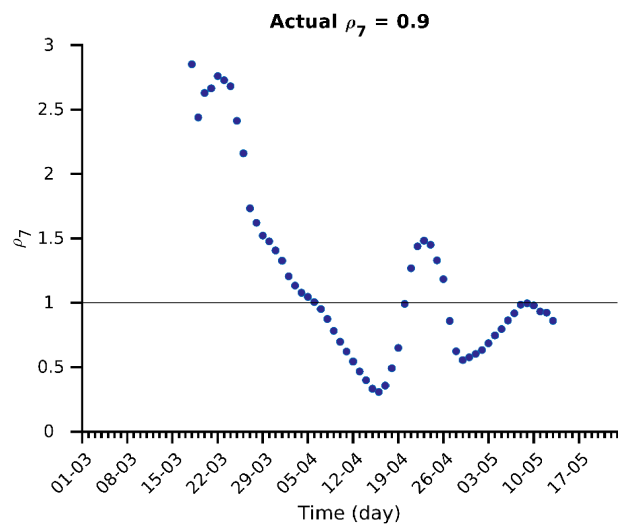
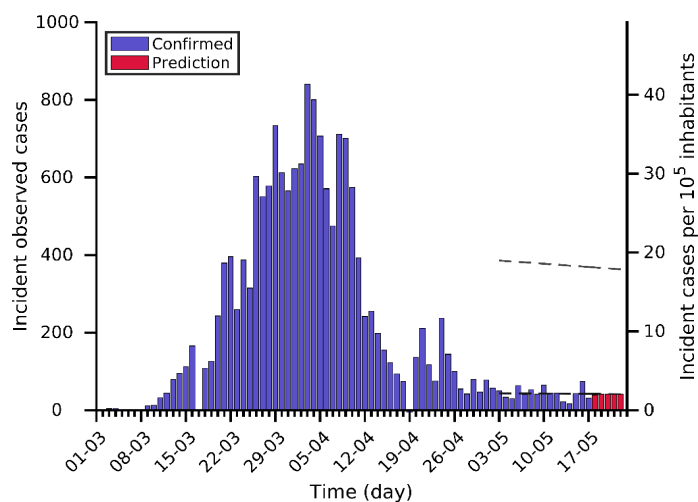
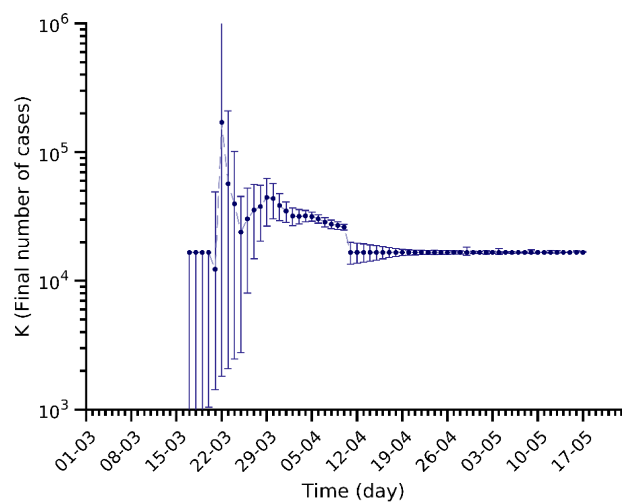
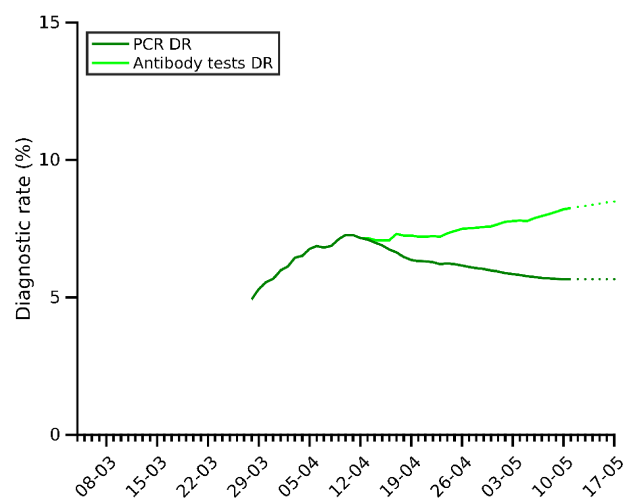
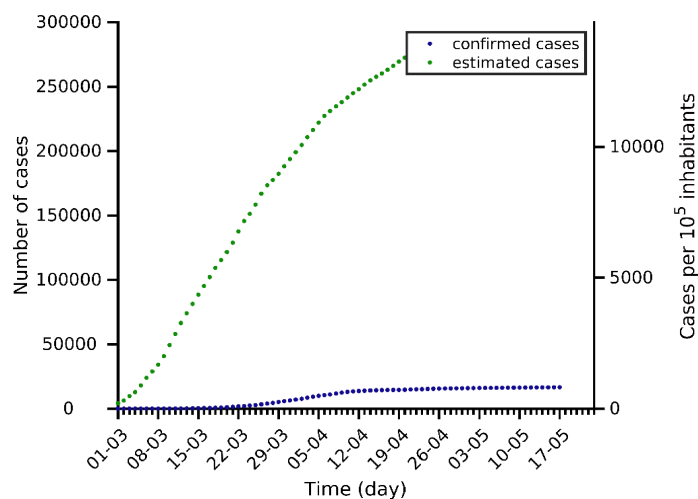
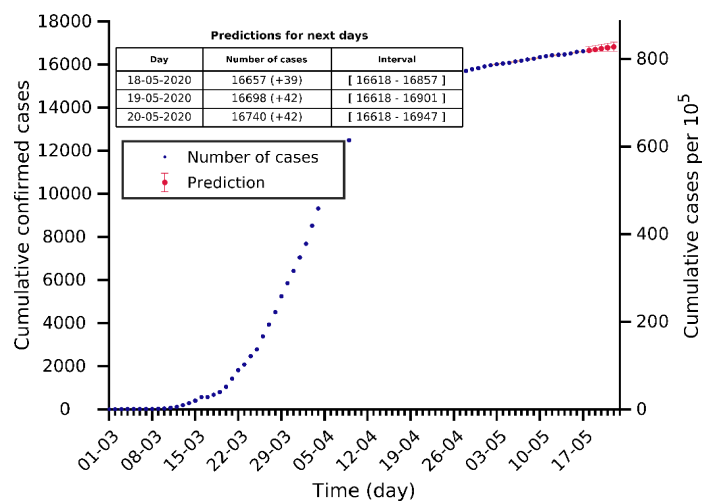
Catalunya 17-05-2020. Population: 7.7M. Current cumulated incidence: 692/10⁵



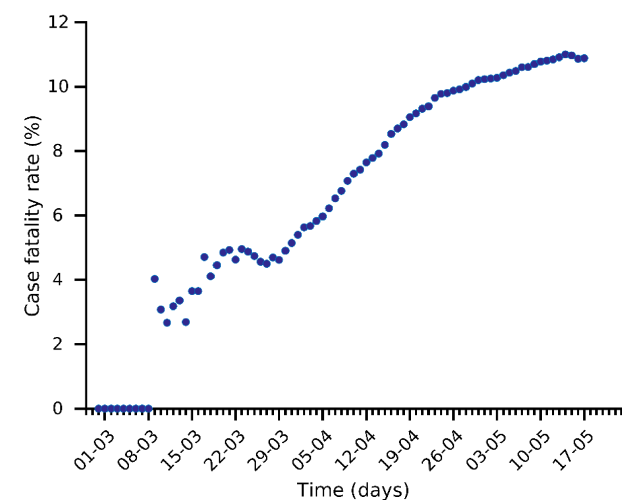
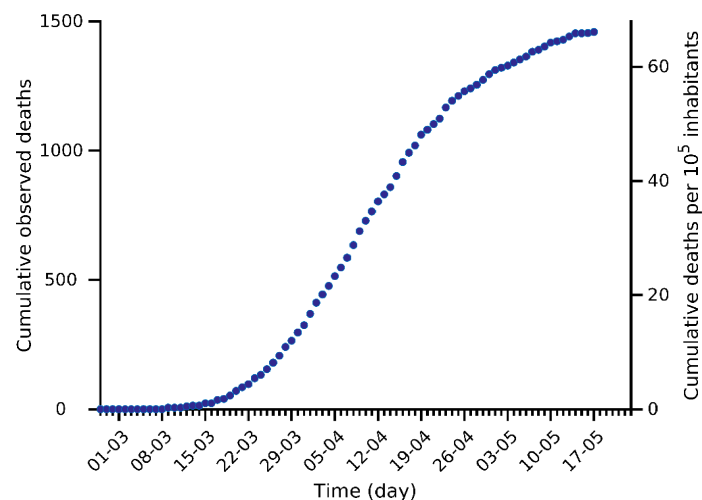
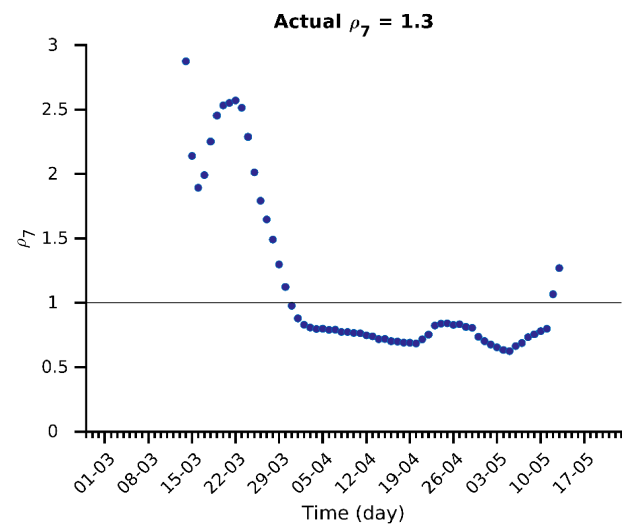
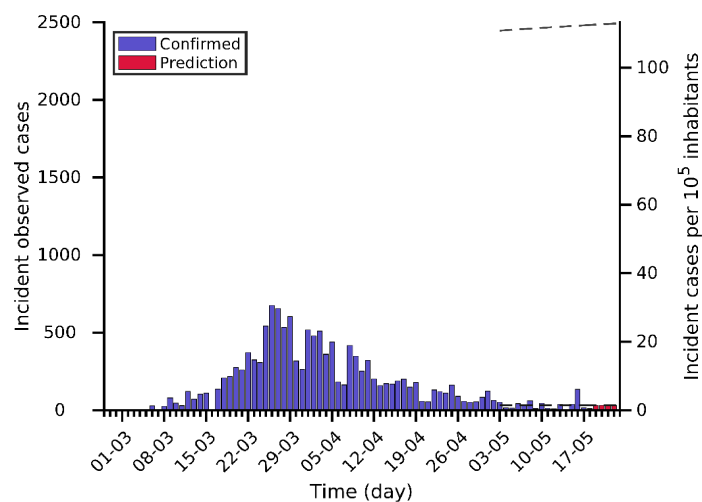
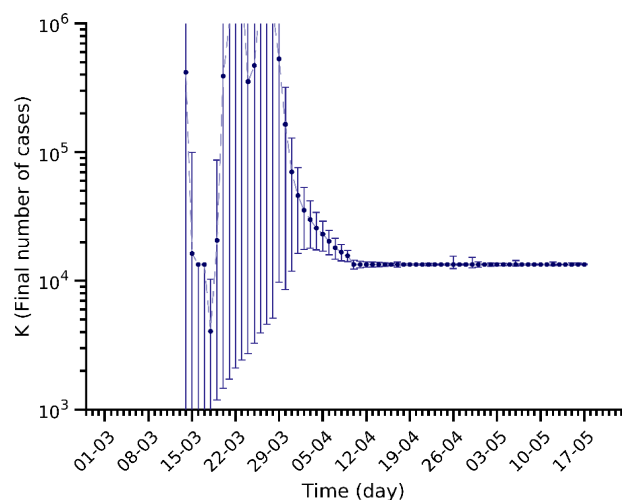
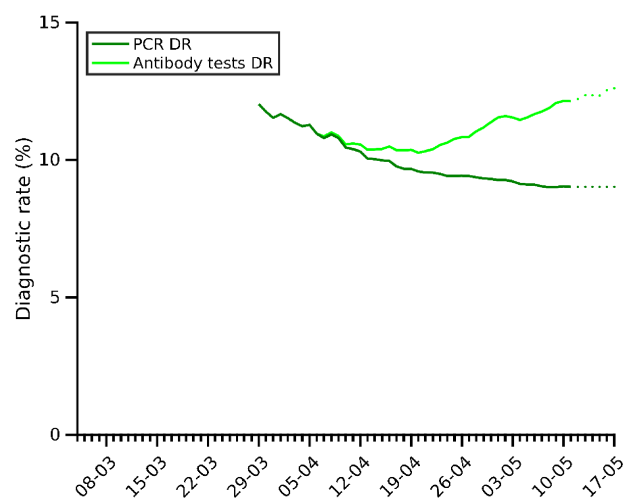
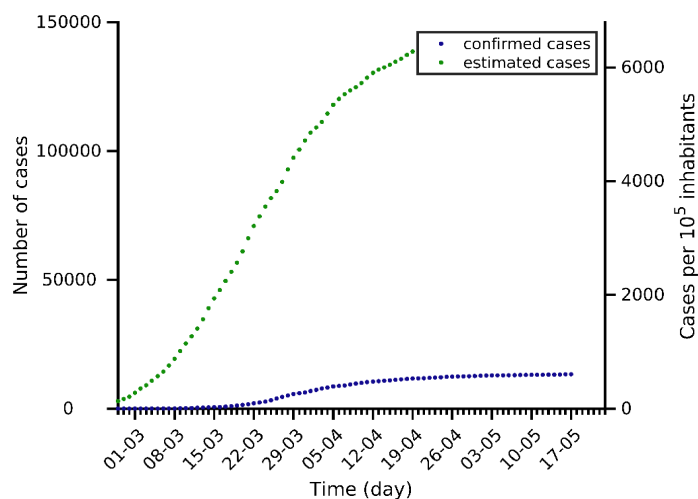
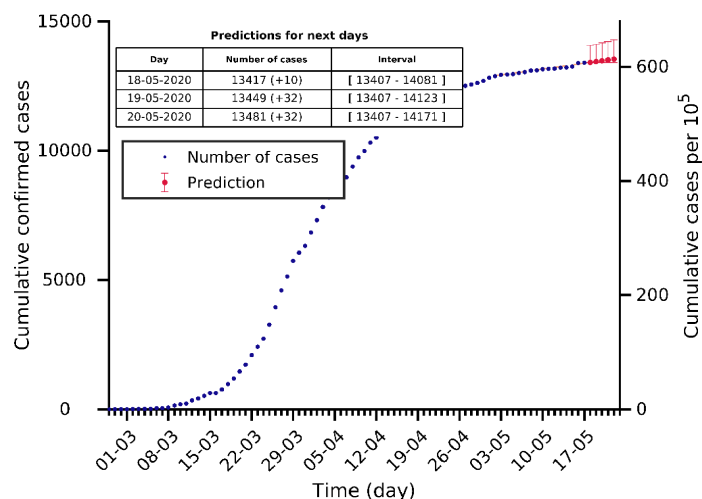
Castilla Leon 17-05-2020. Population: 2.4M. Current cumulated incidence: 770/10⁵



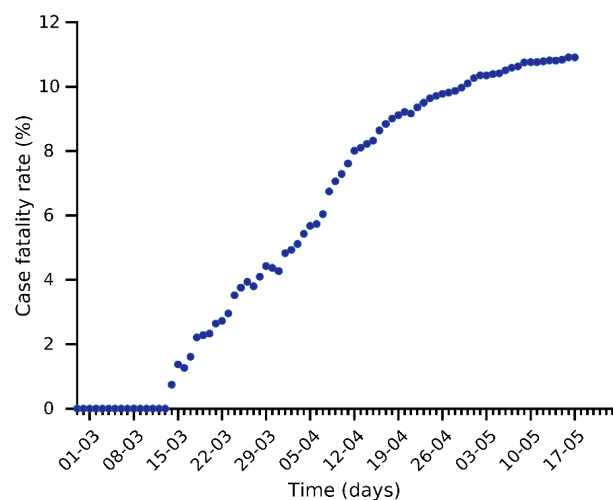
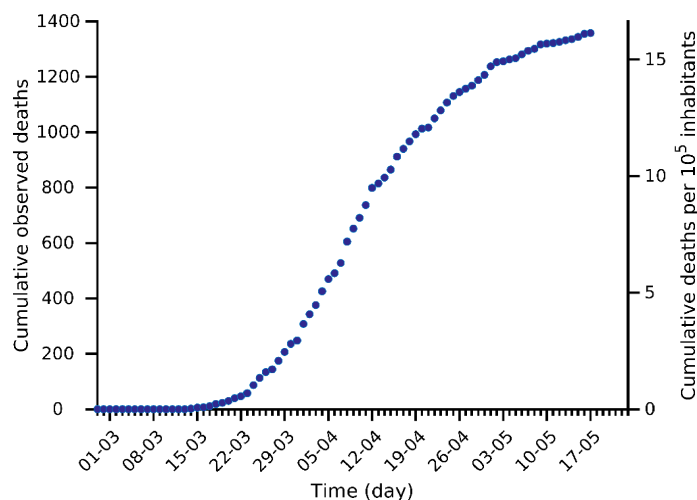
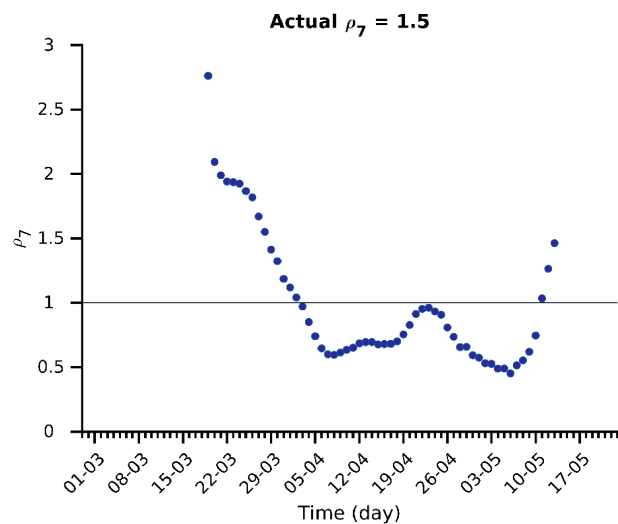
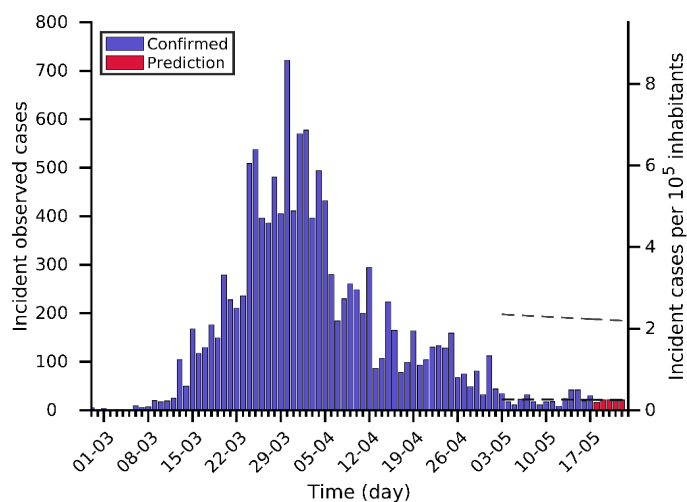
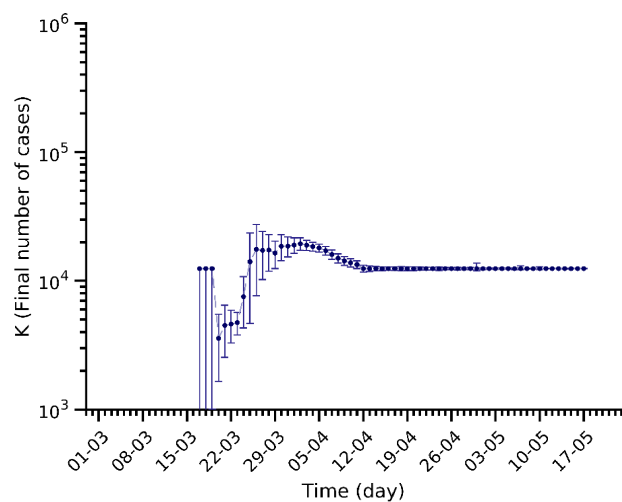
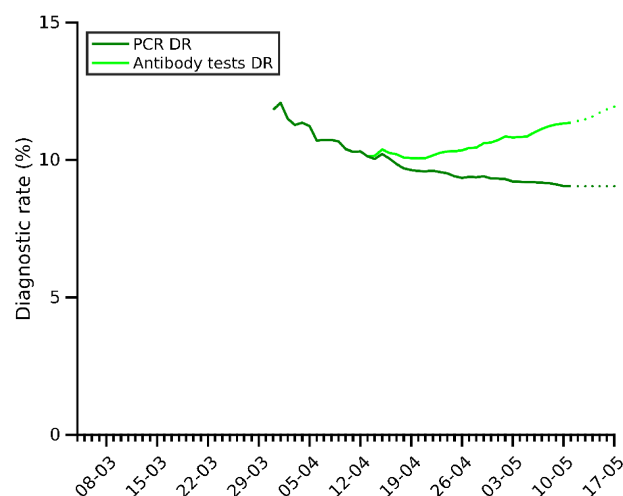
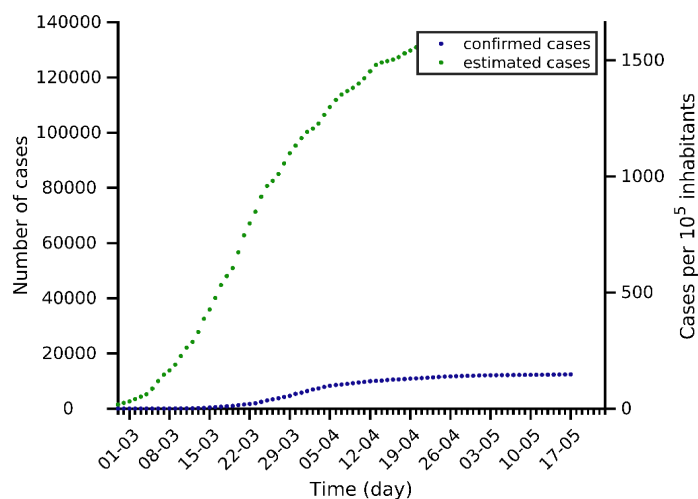
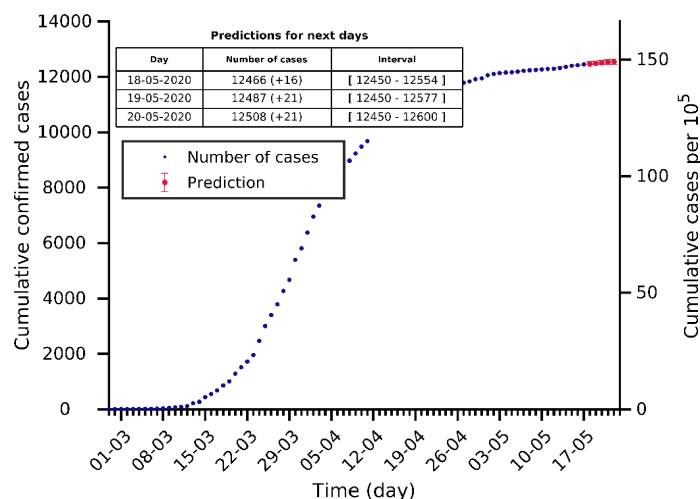
Castilla-La Mancha 17-05-2020. Population: 2.0M. Current cumulated incidence: 81



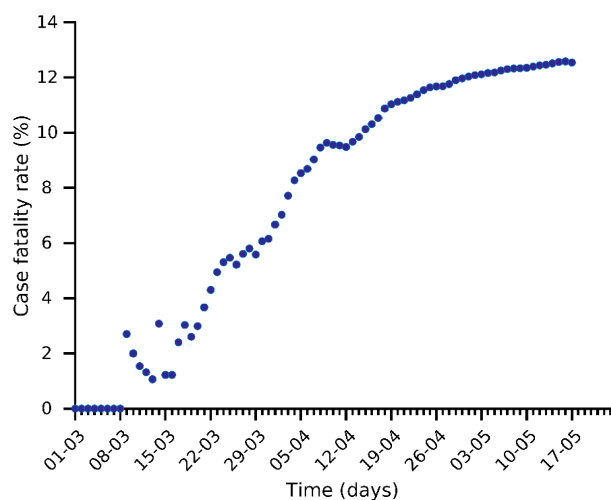
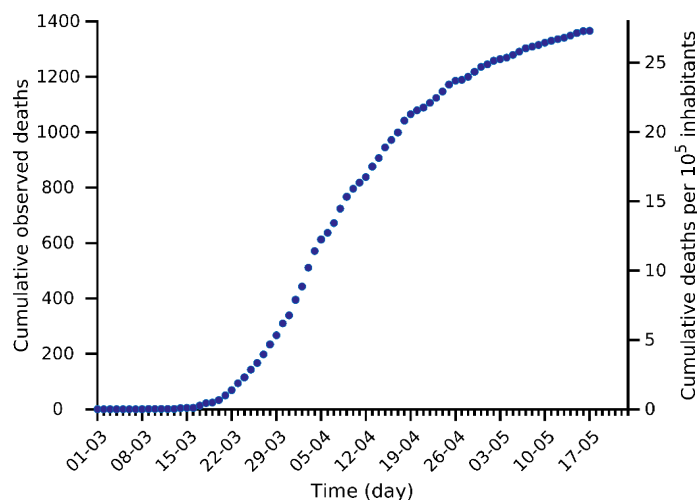
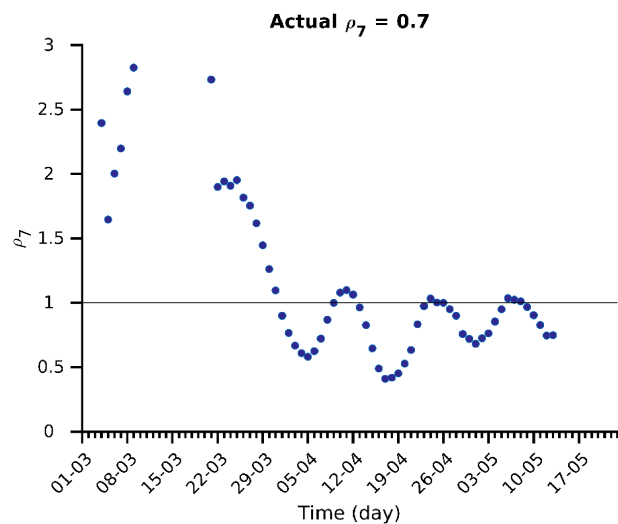
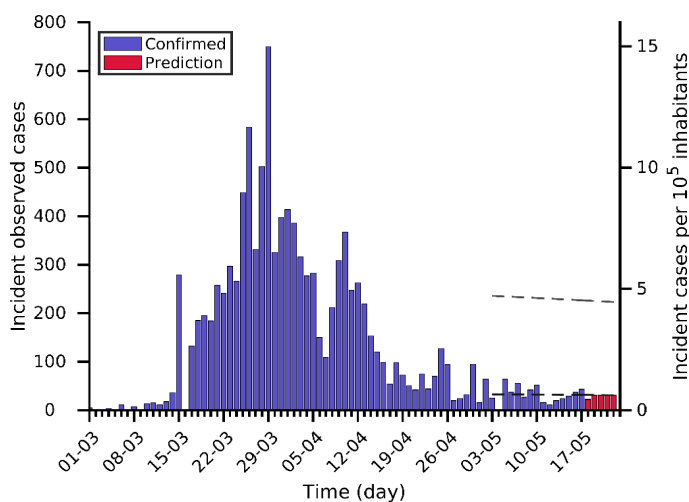
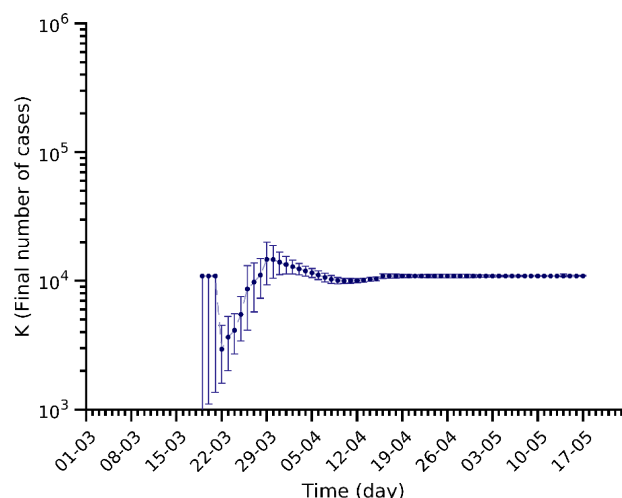
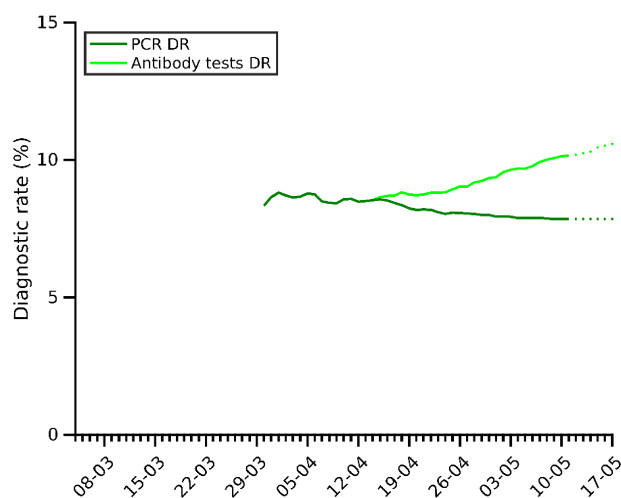
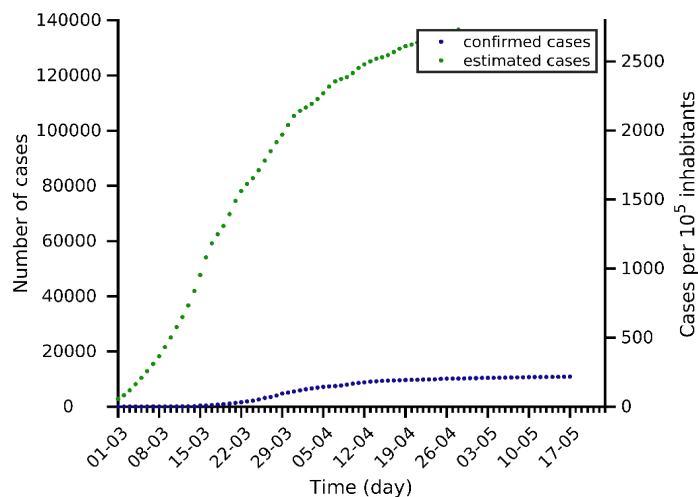
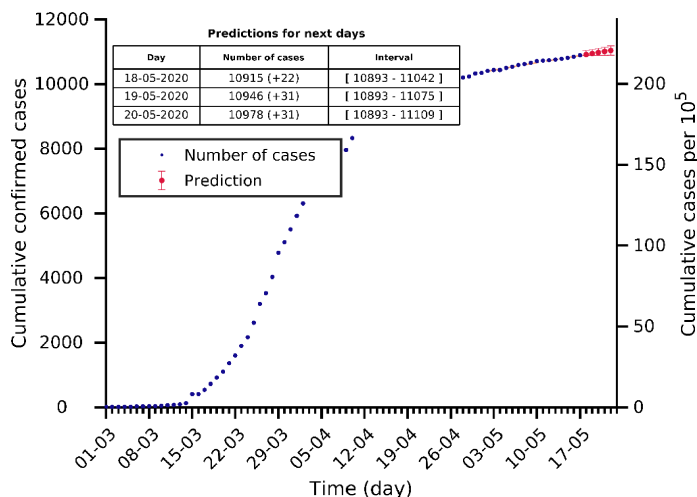
Euskadi 17-05-2020. Population: 2.2M. Current cumulated incidence: 607/10⁵



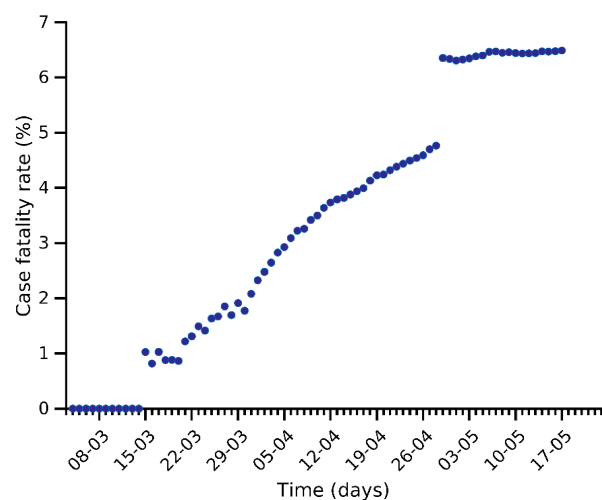
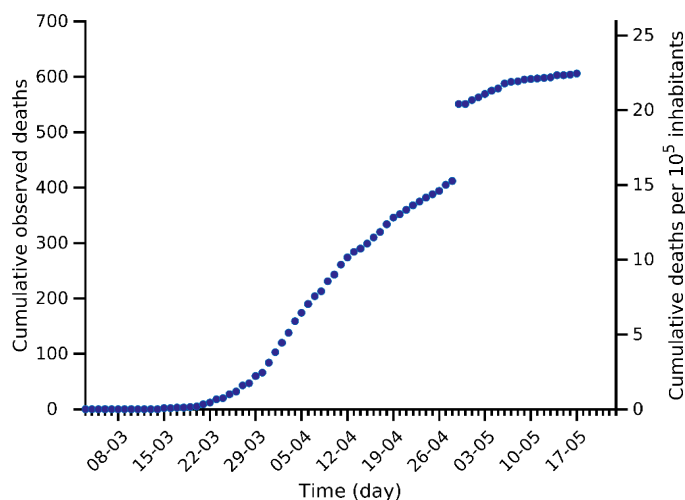
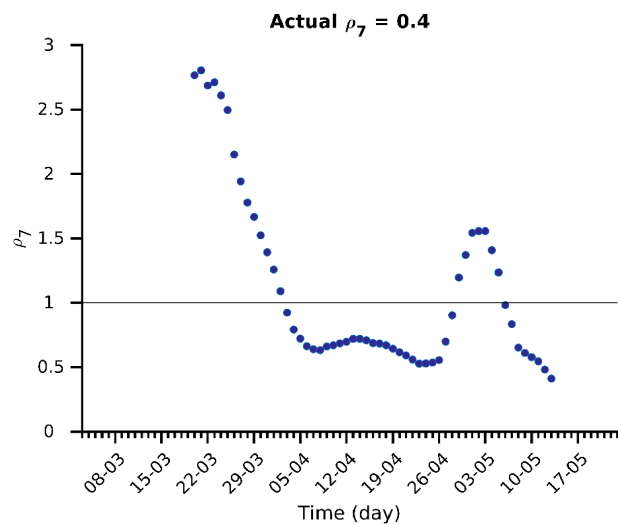
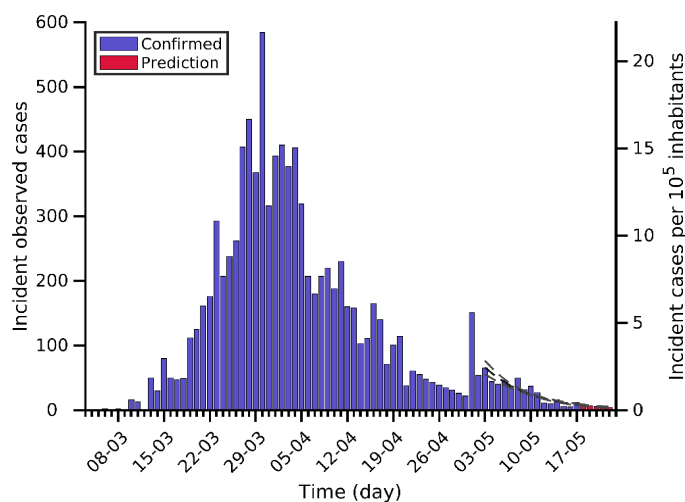
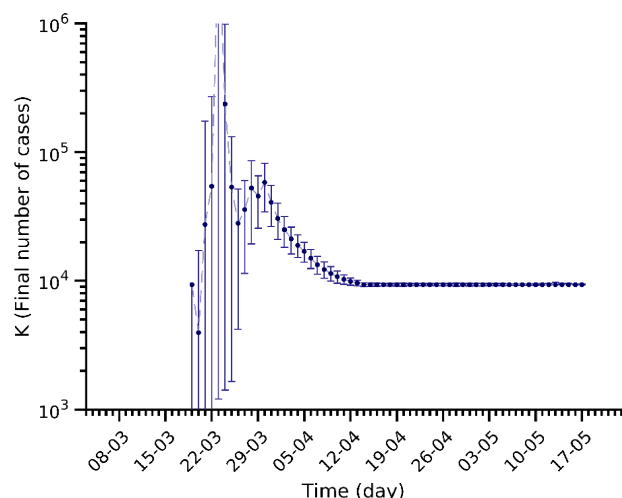
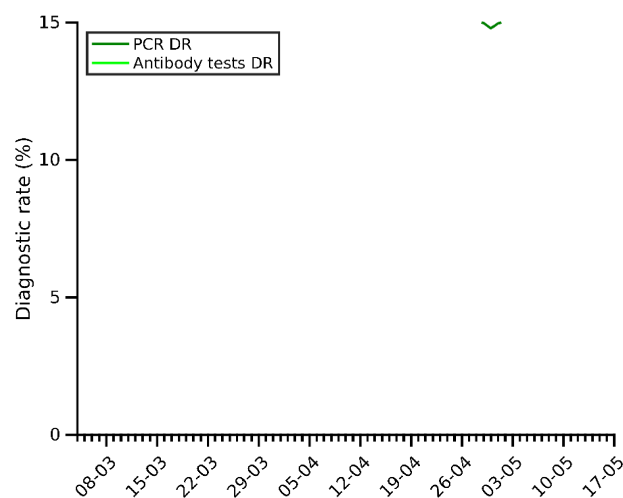
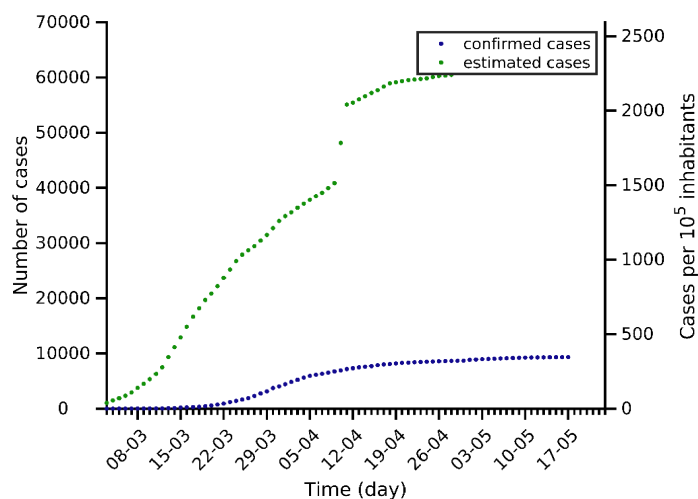
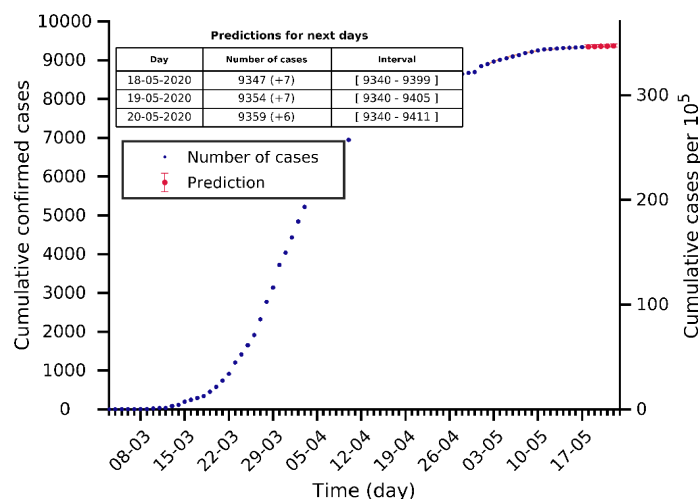
Andalucia 17-05-2020. Population: 8.4M. Current cumulated incidence: 148/10⁵



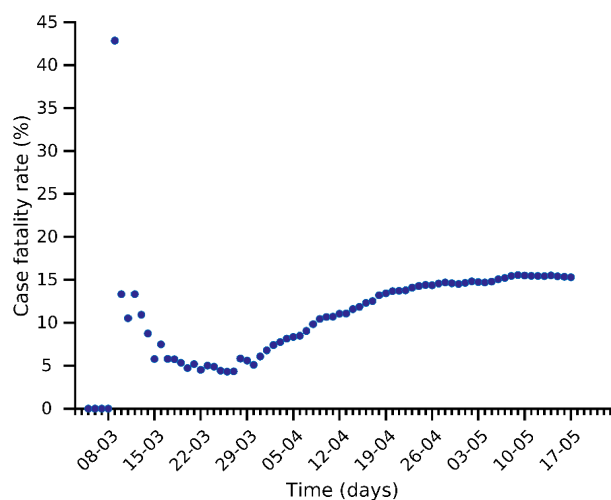
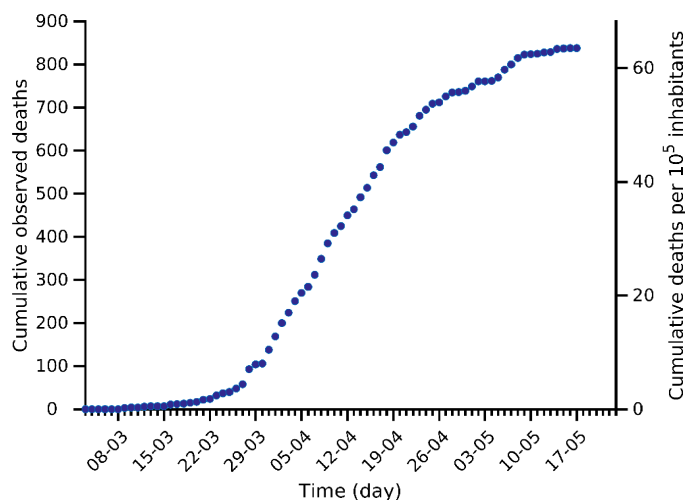
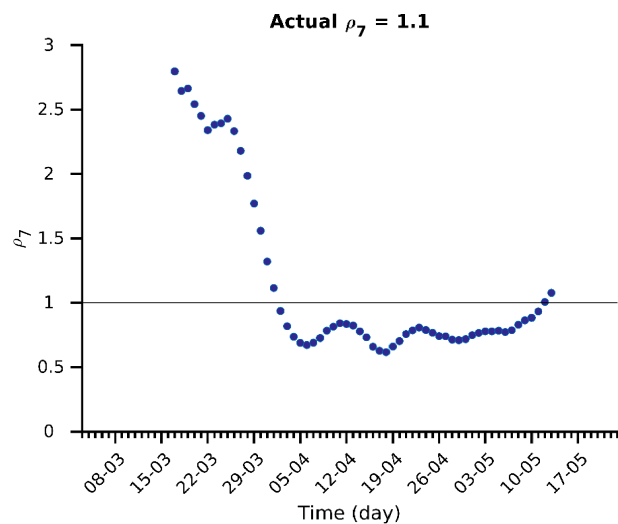
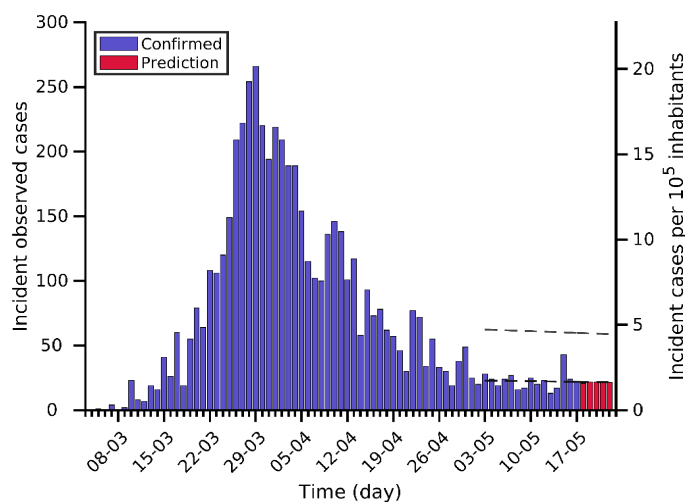
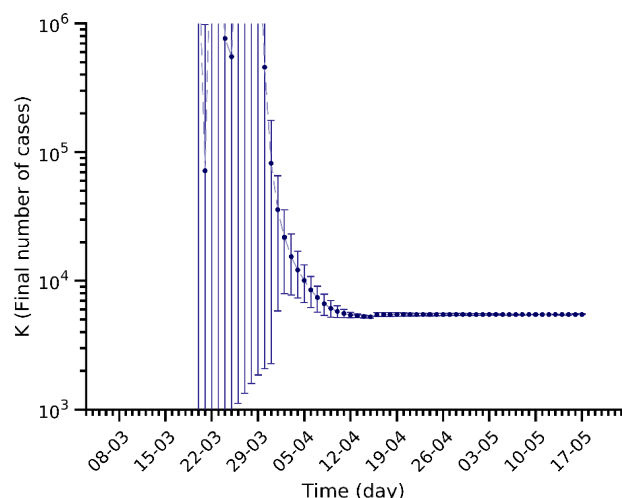
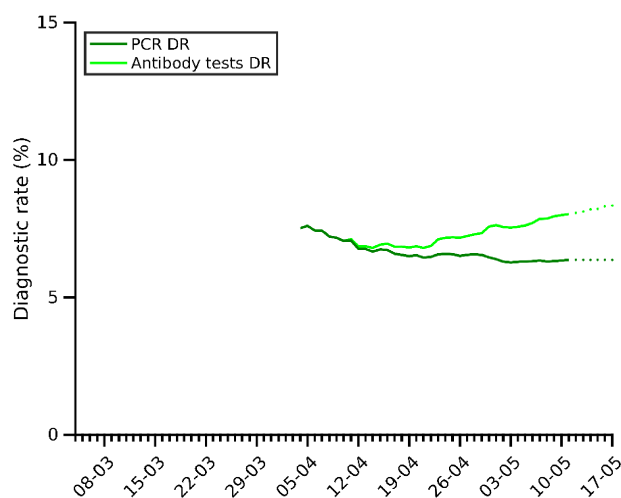
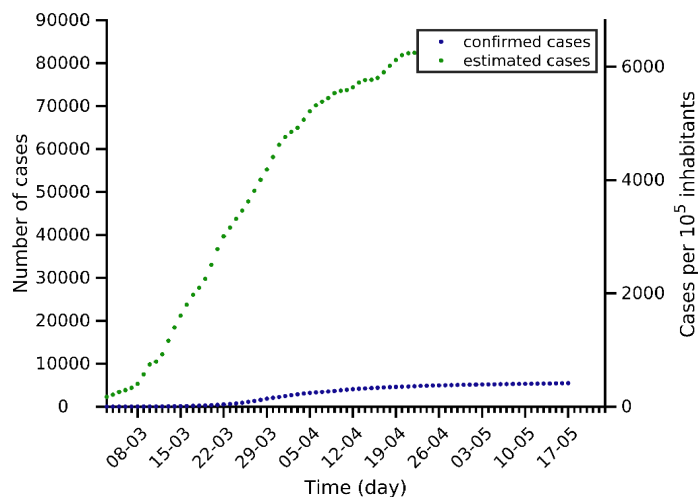
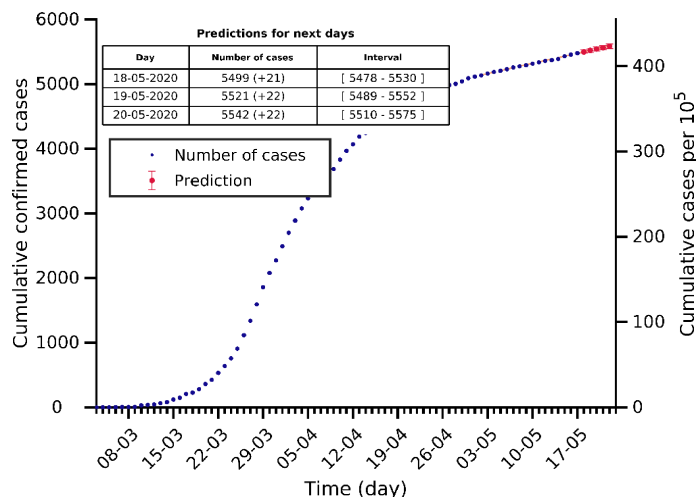
C Valenciana 17-05-2020. Population: 5.0M. Current cumulated incidence: 218/10⁵



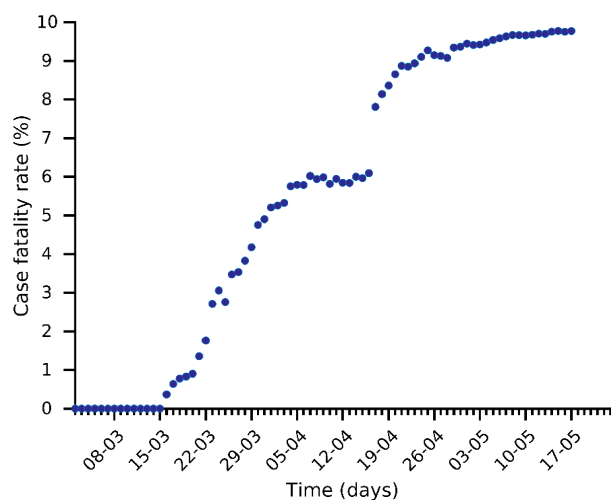
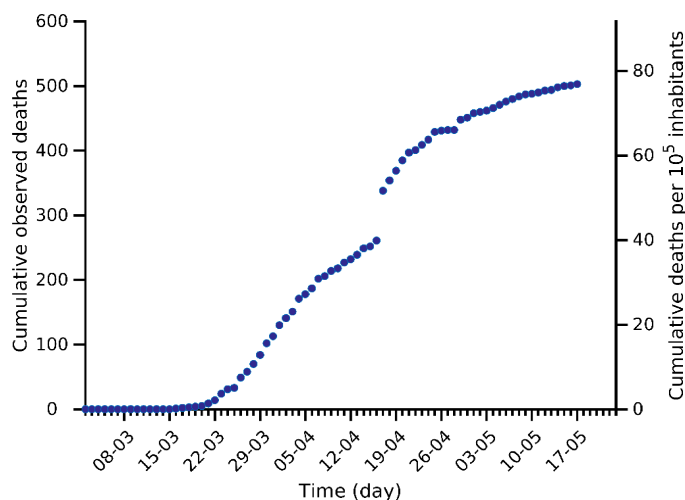
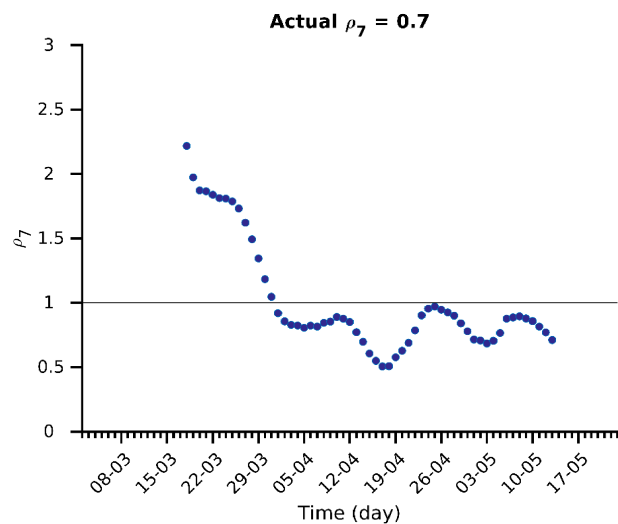
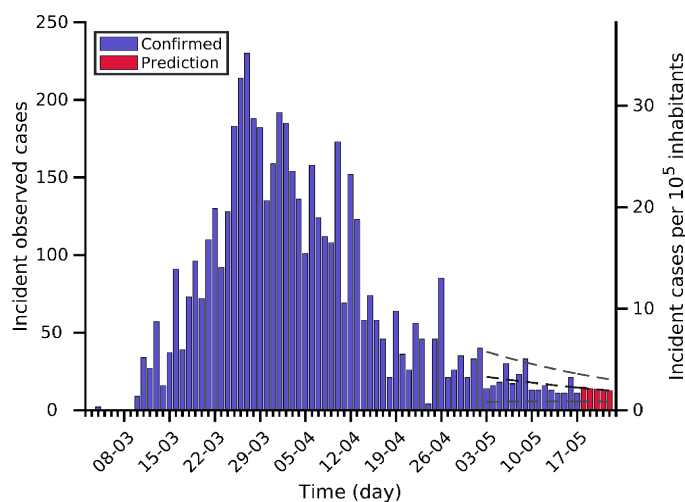
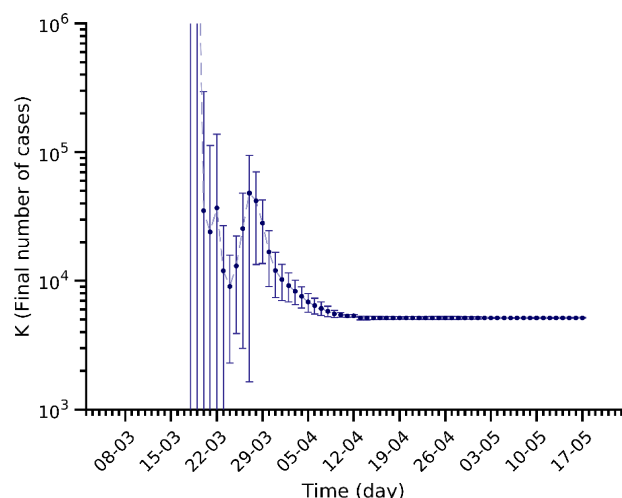
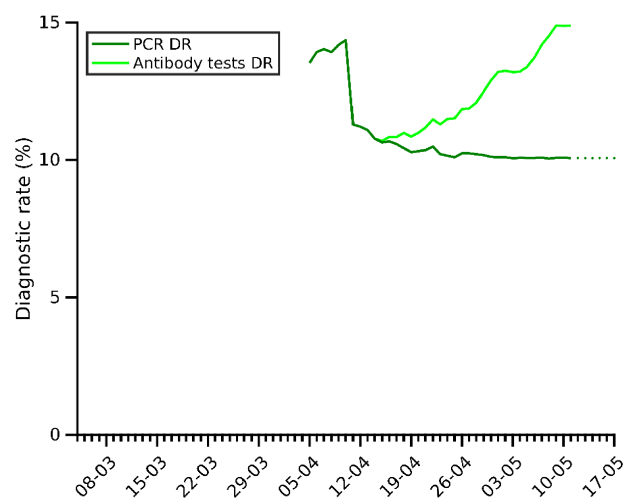
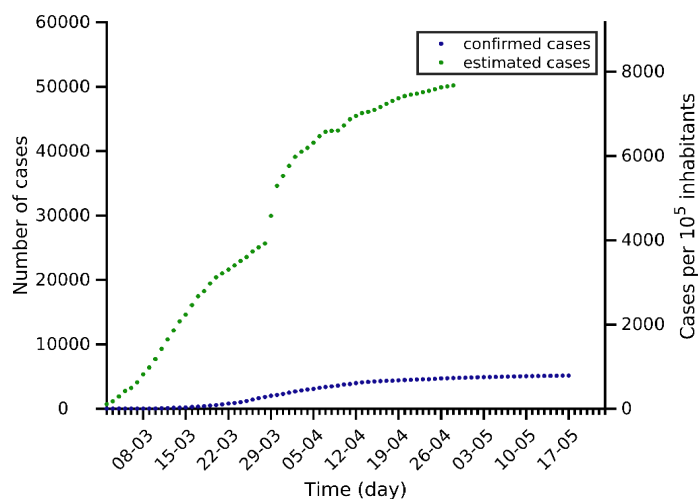
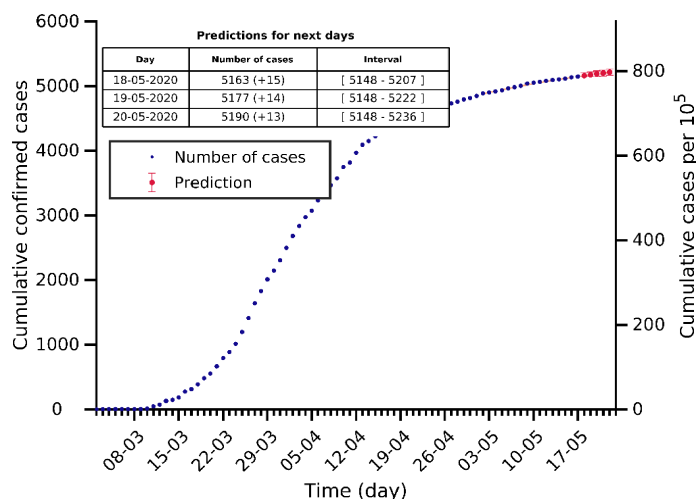
Galicia 17-05-2020. Population: 2.7M. Current cumulated incidence: 346/10⁵



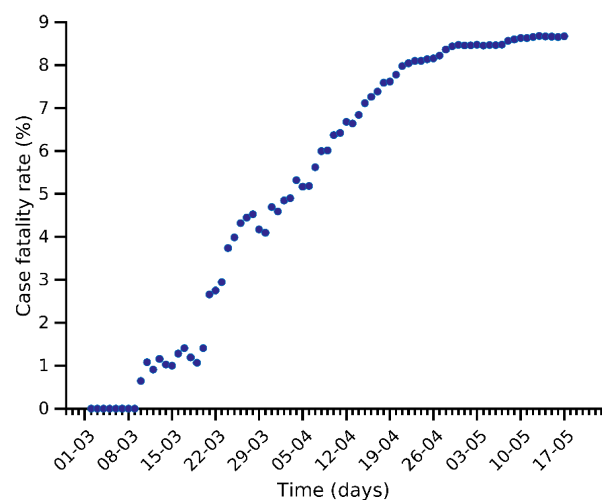
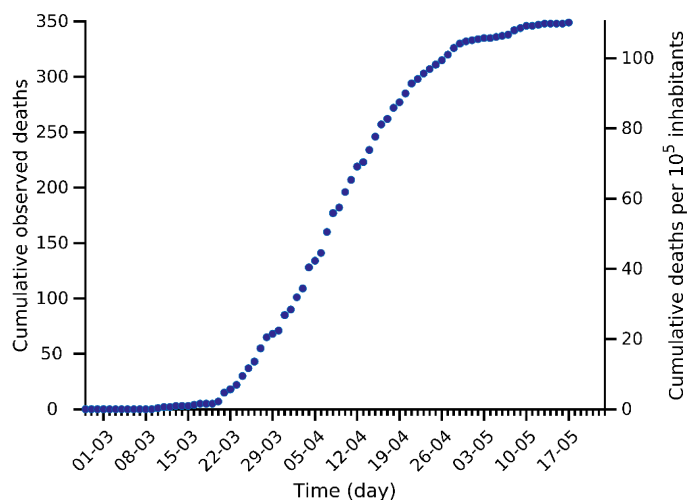
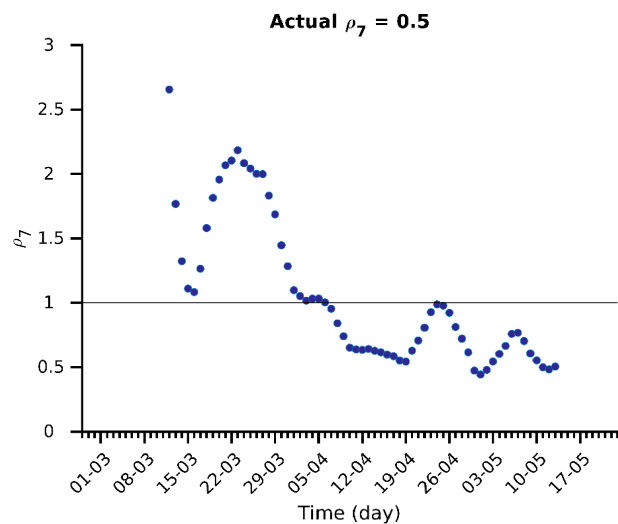
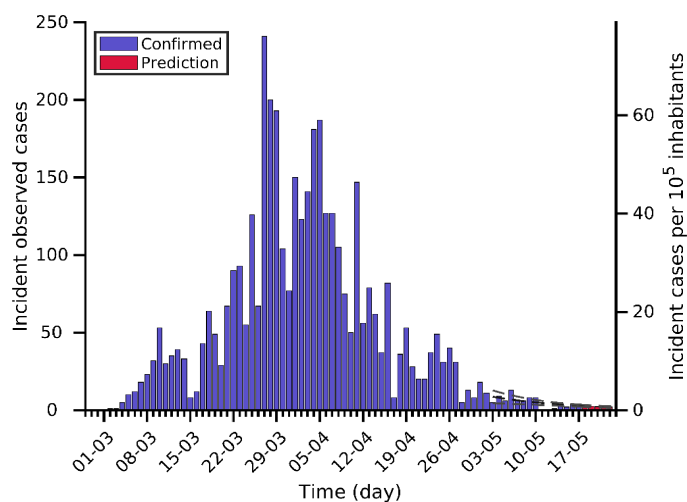
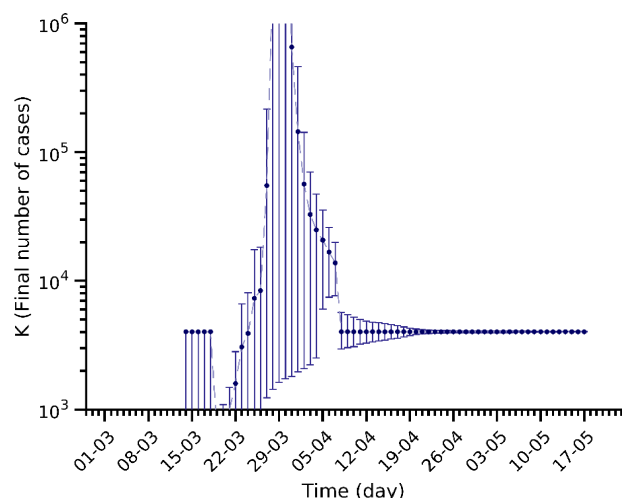
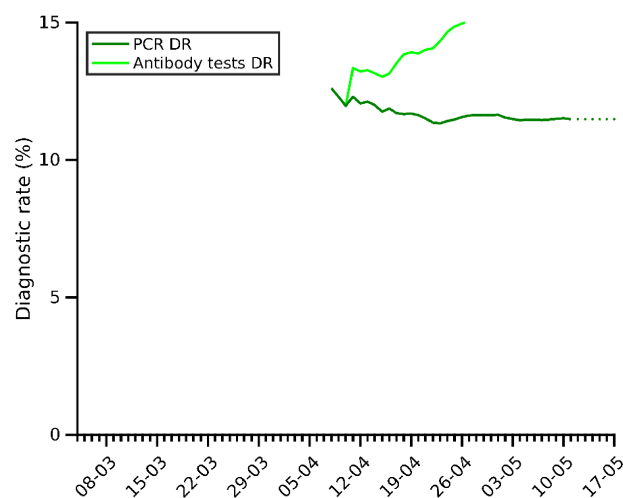
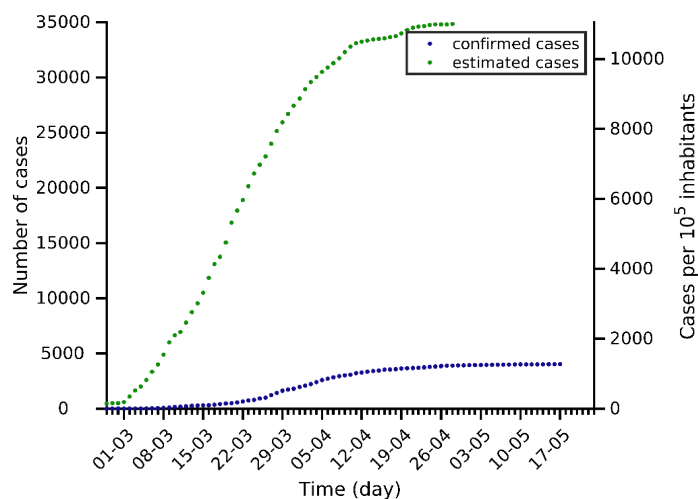
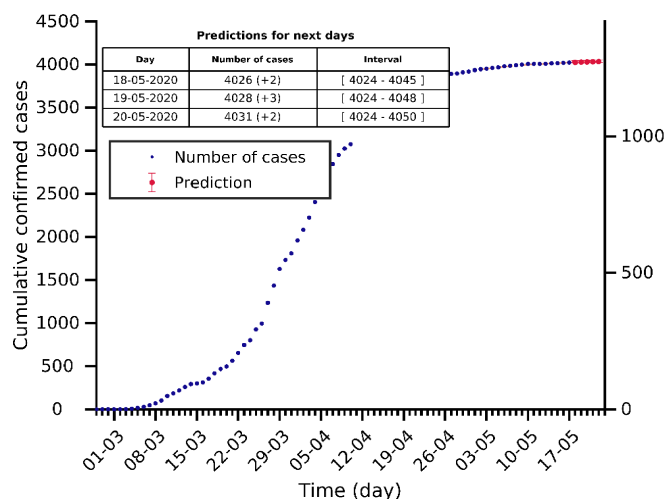
Aragon 17-05-2020. Population: 1.3M. Current cumulated incidence: 415/10⁵



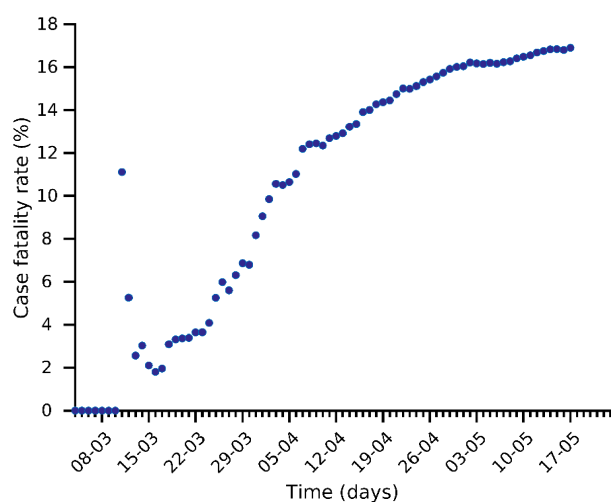
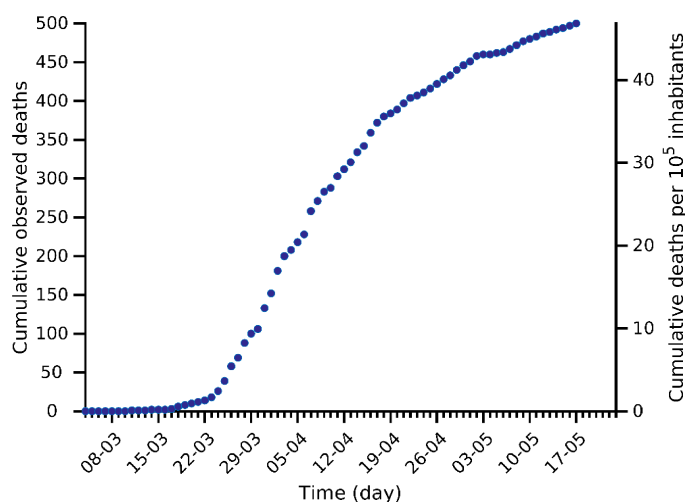
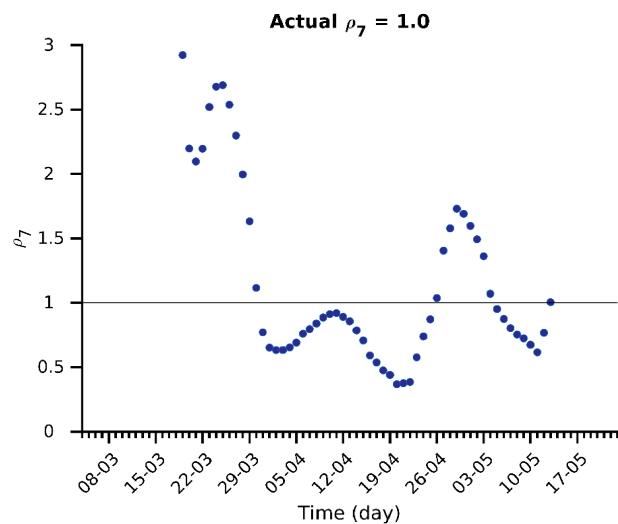
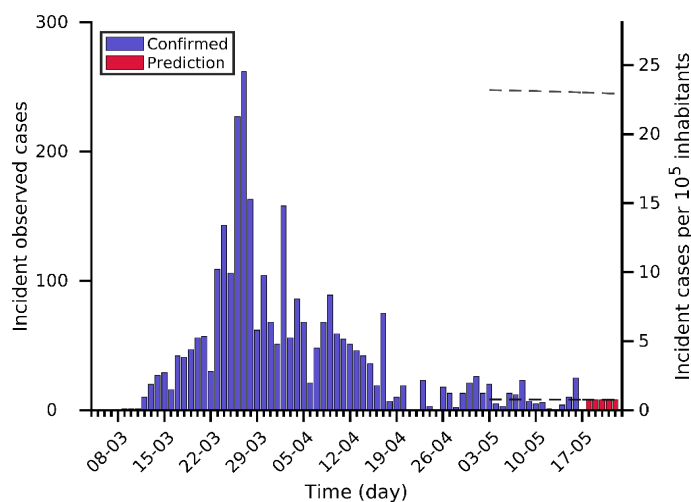
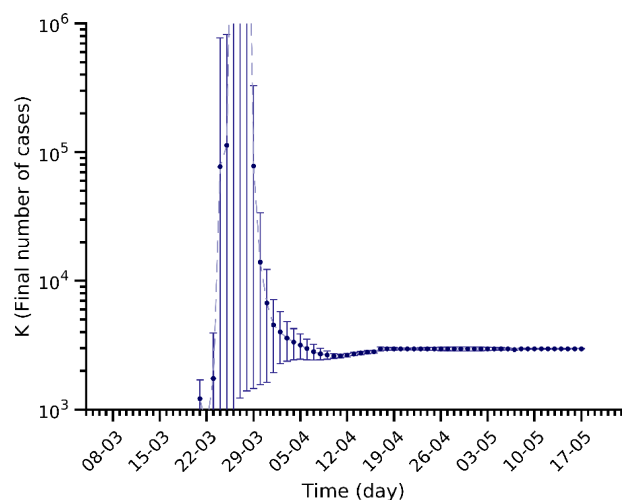
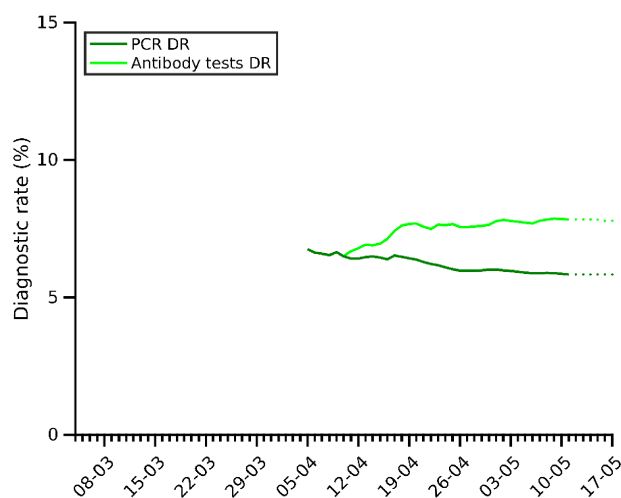
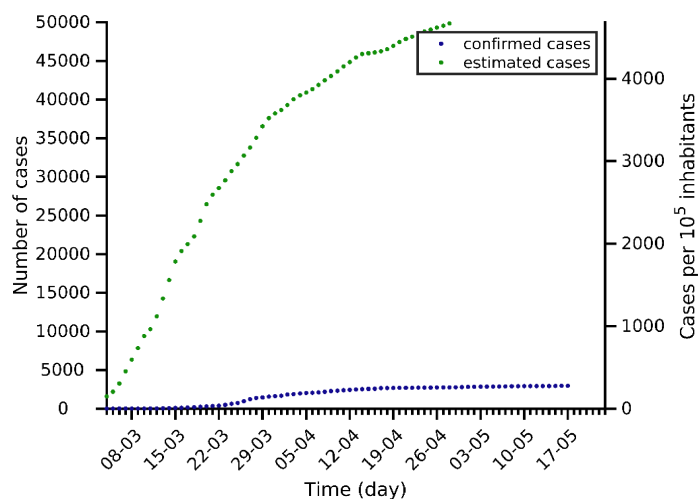
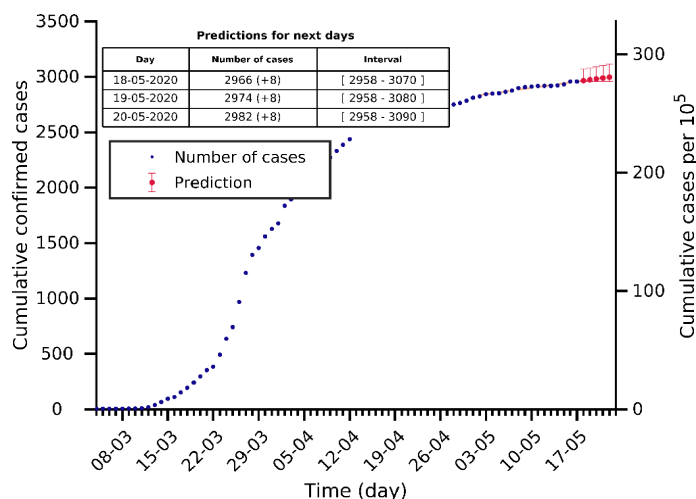
Navarra 17-05-2020. Population: 0.7M. Current cumulated incidence: 787/10⁵



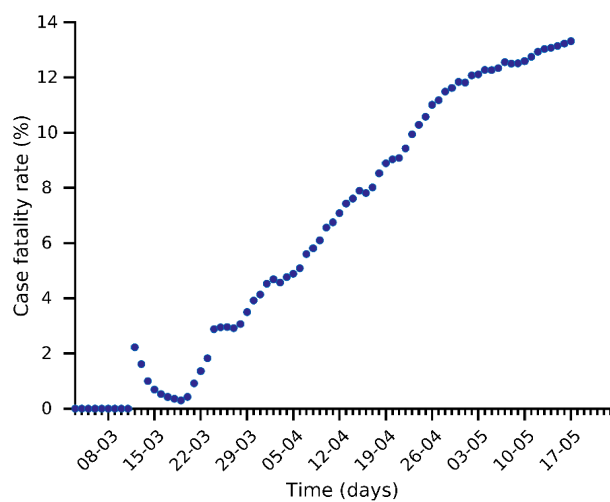
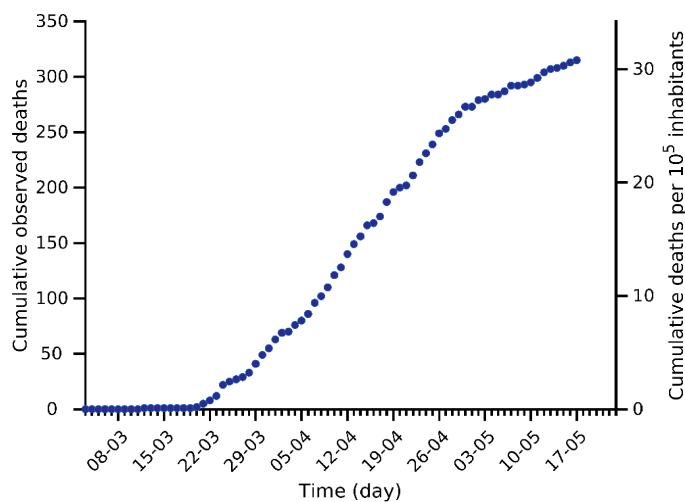
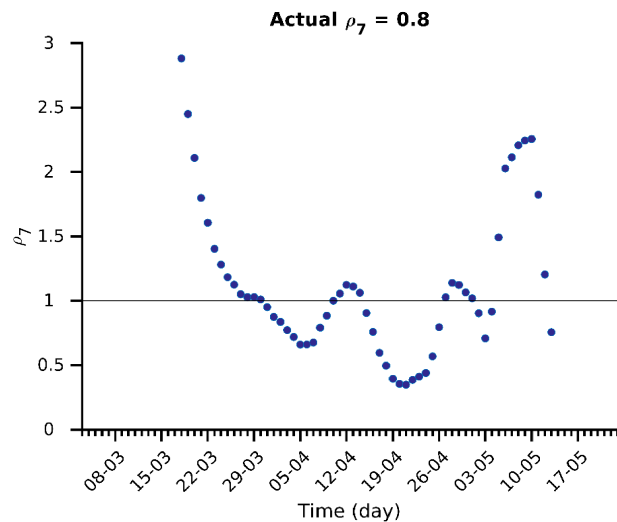
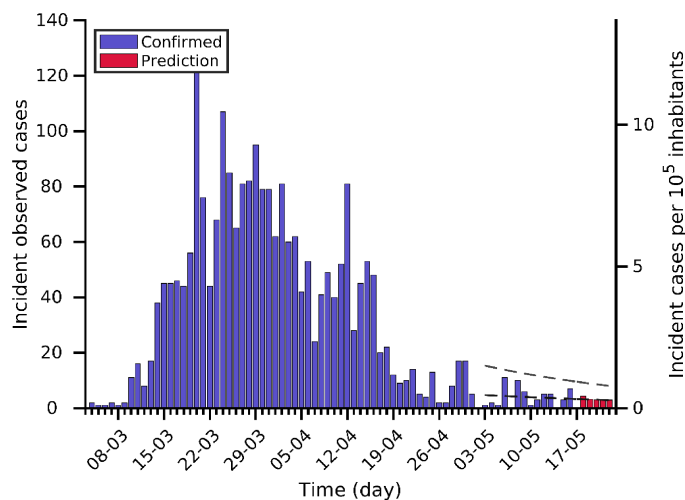
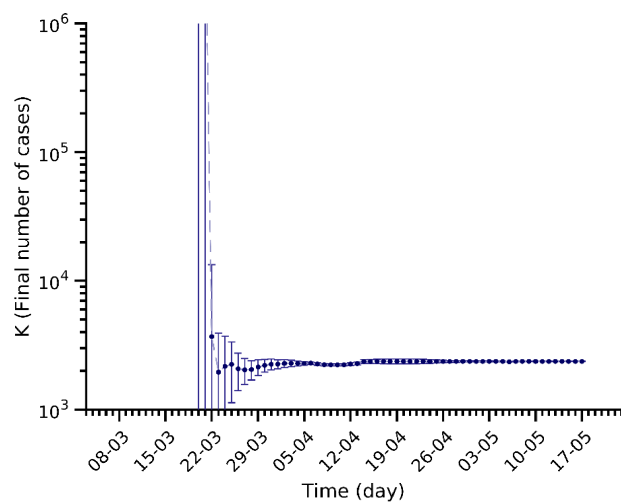
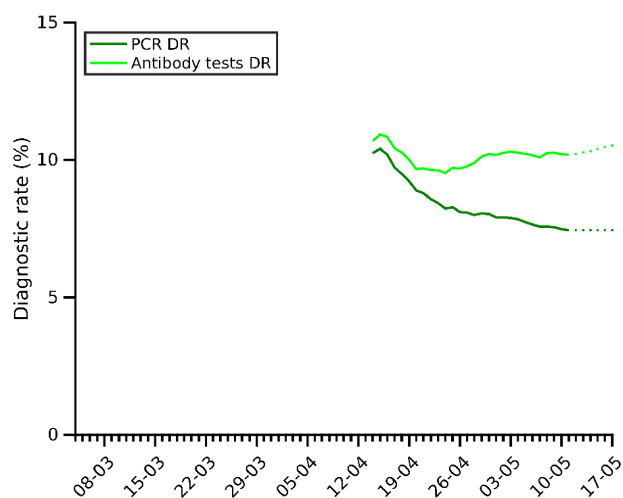
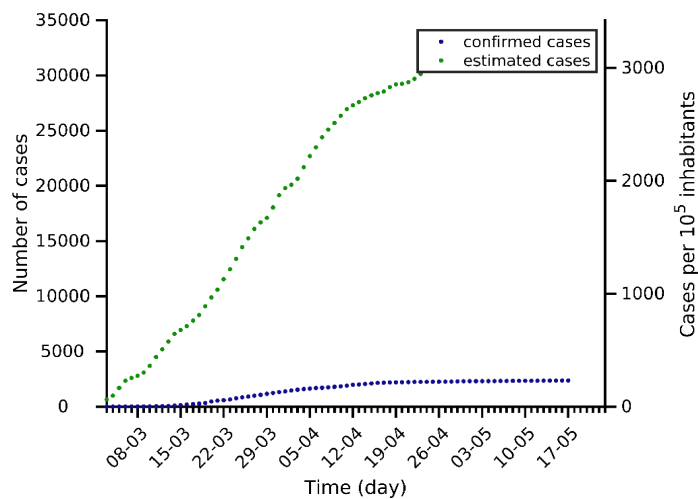
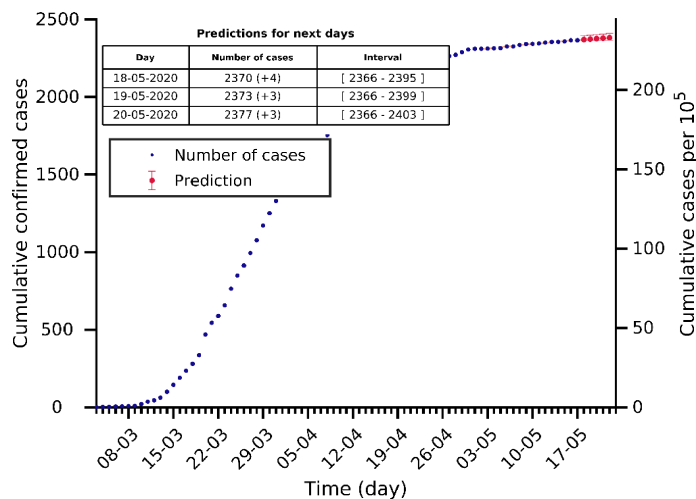
La Rioja 17-05-2020. Population: 0.3M. Current cumulated incidence: 1270/10⁵



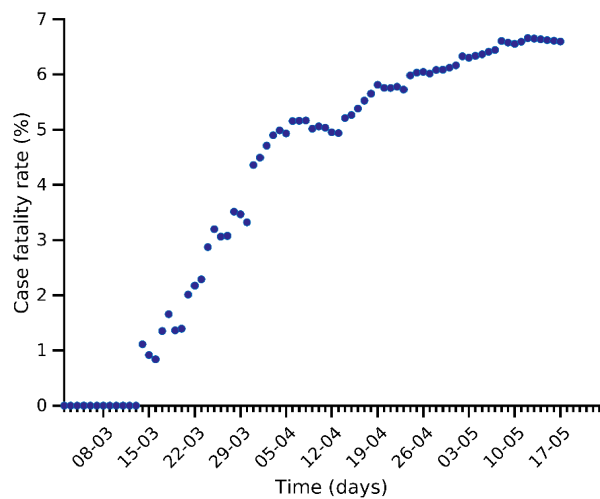
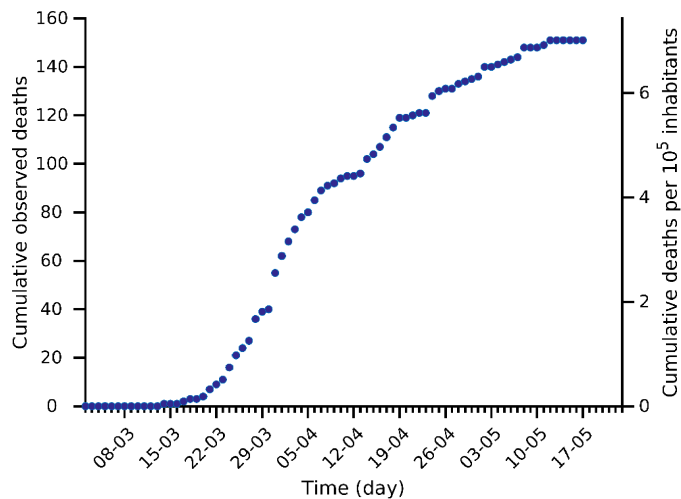
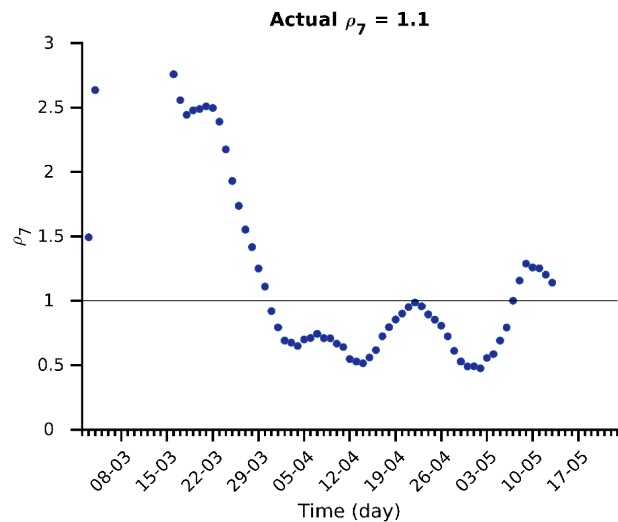
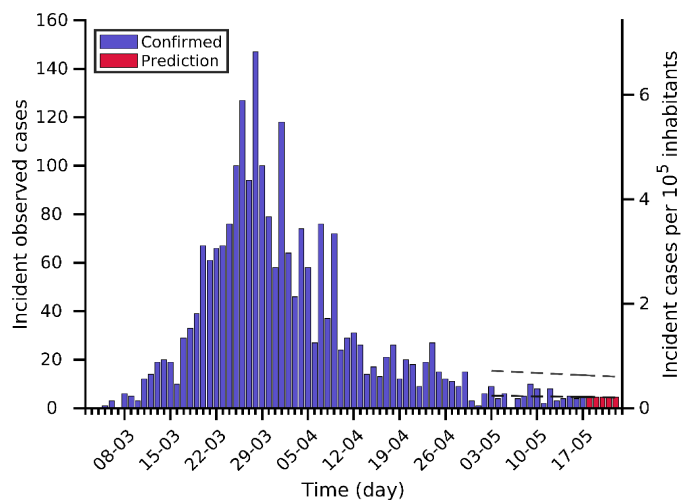
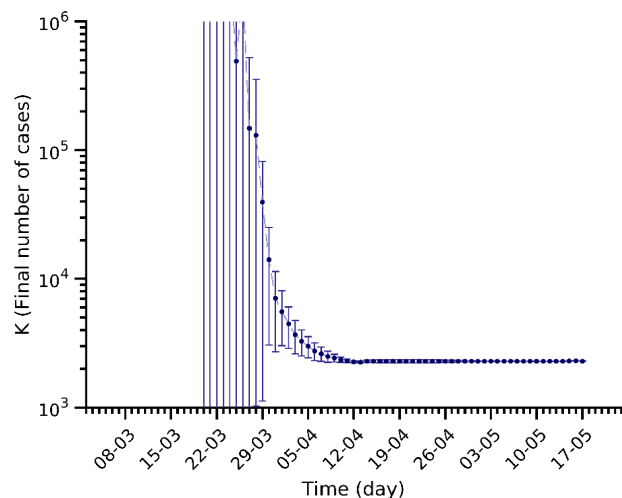
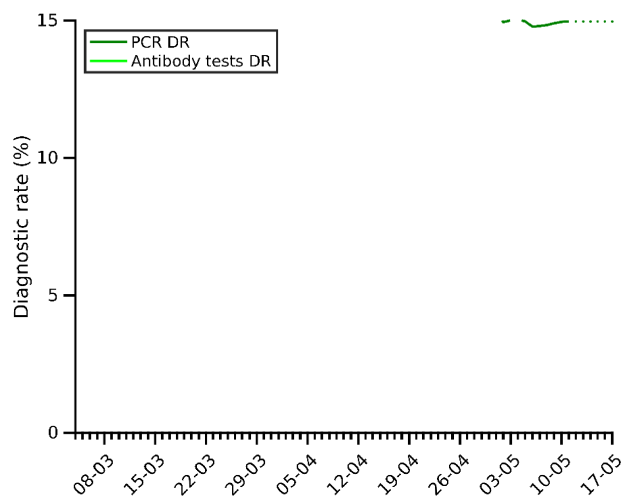
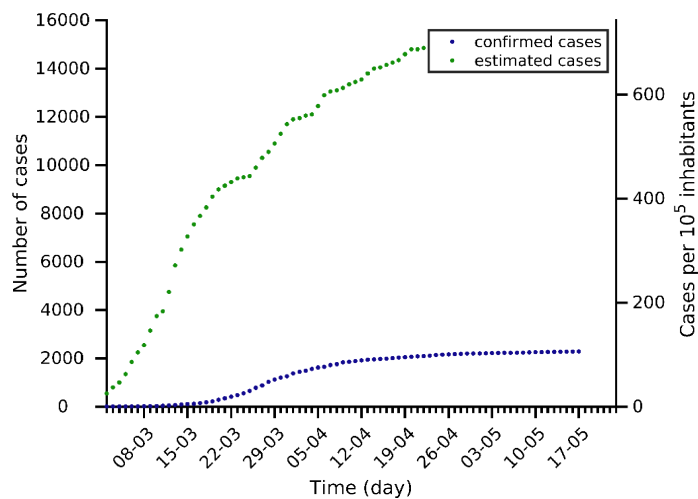
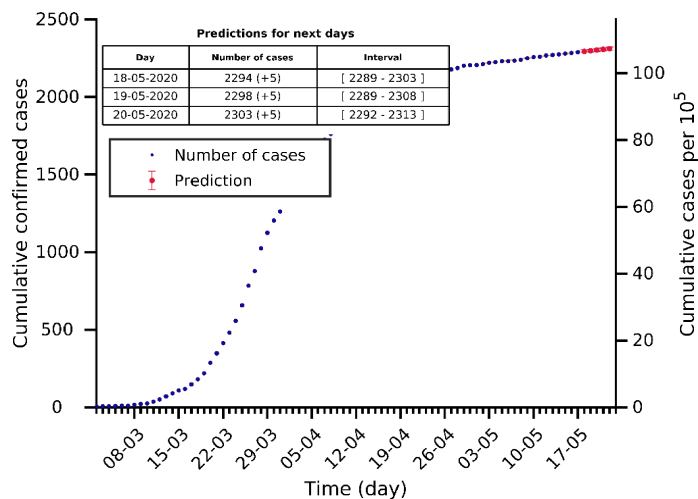
Extremadura 17-05-2020. Population: 1.1M. Current cumulated incidence: 277/10⁵



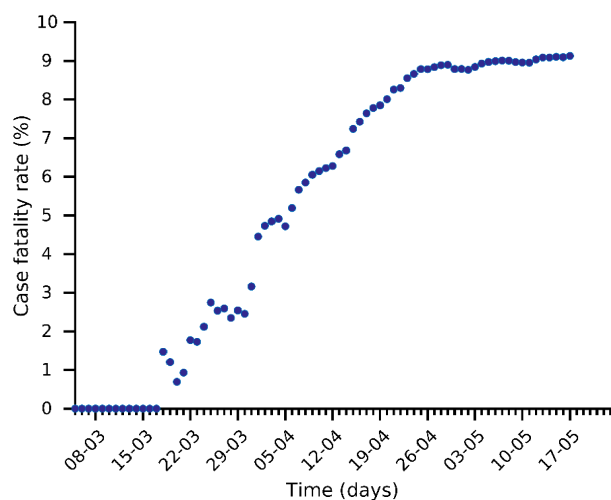
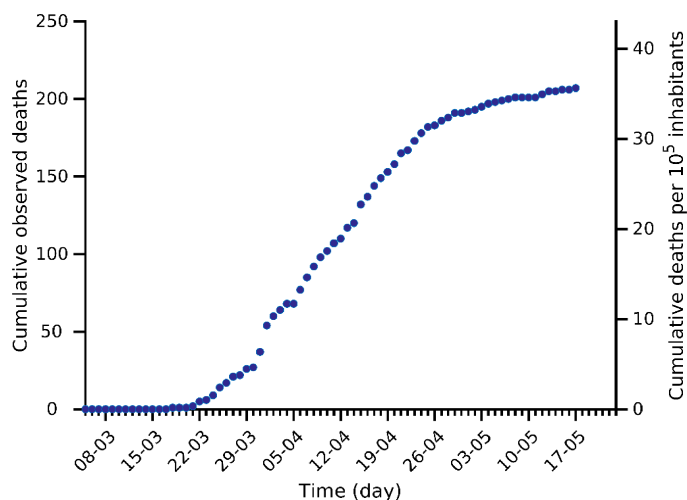
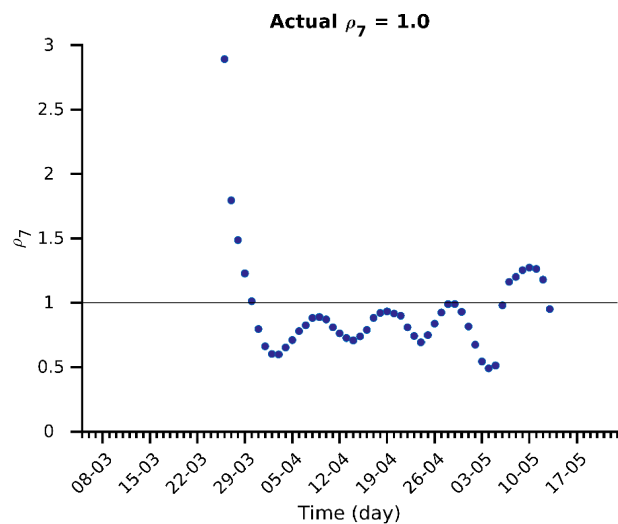
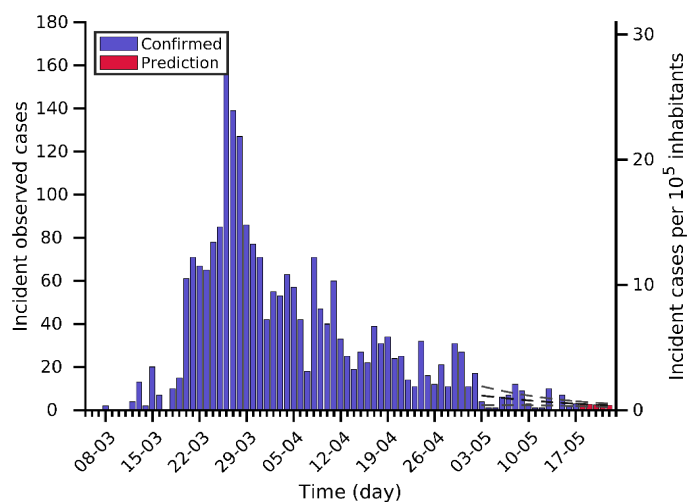
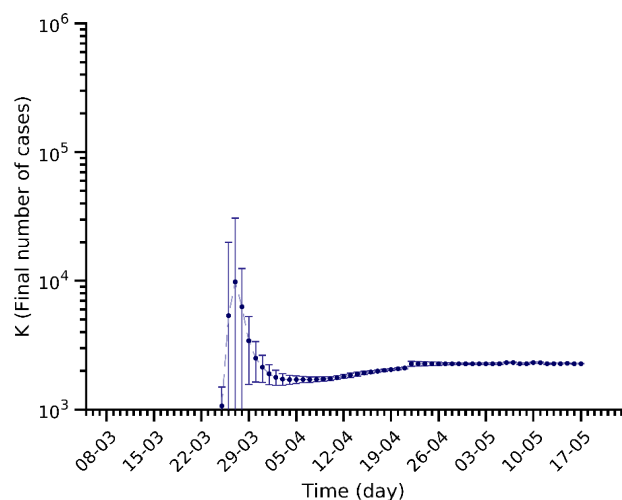
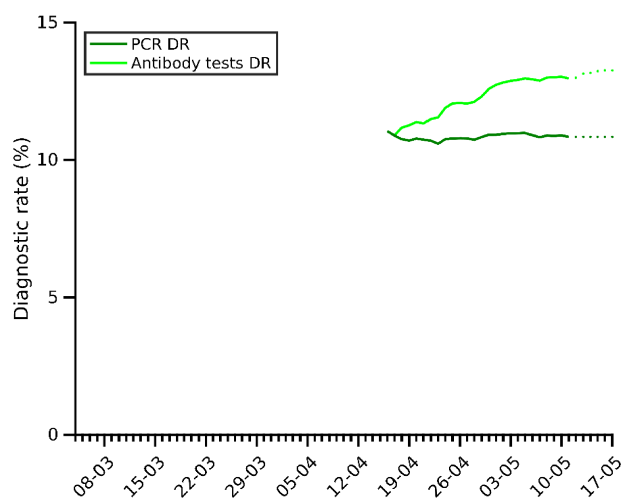
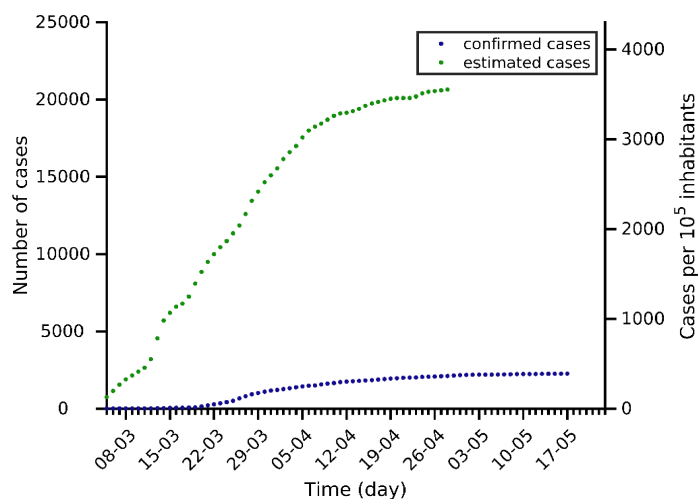
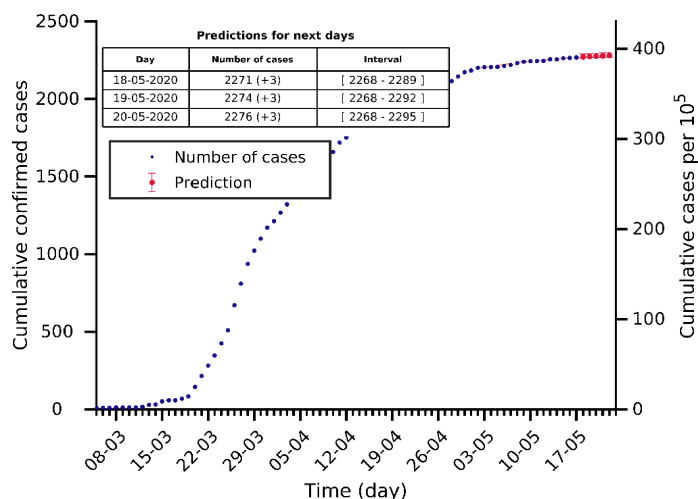
Asturias 17-05-2020. Population: 1.0M. Current cumulated incidence: 231/10⁵



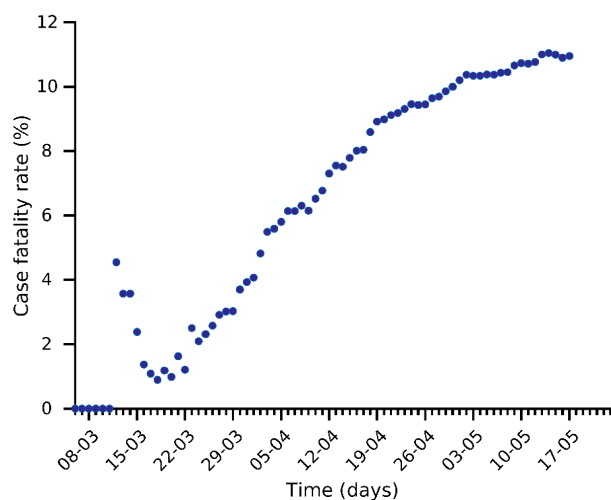
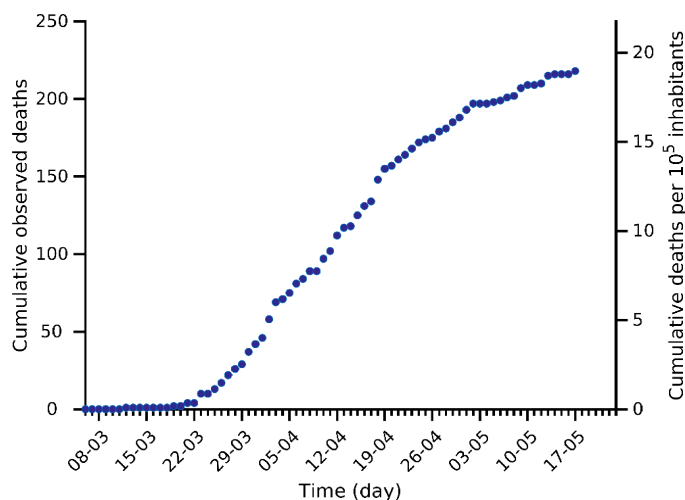
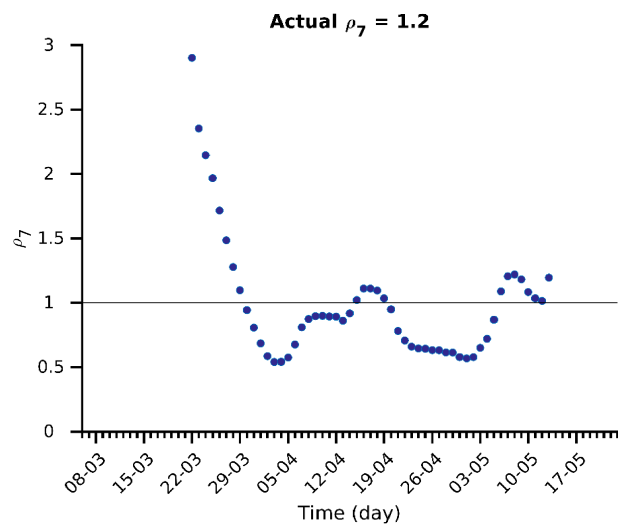
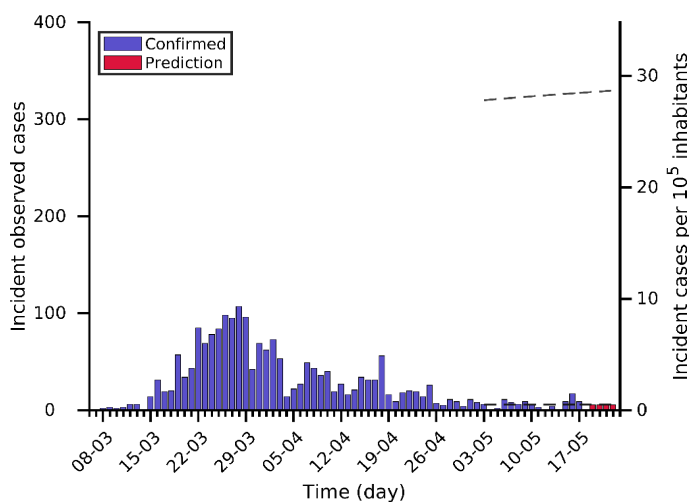
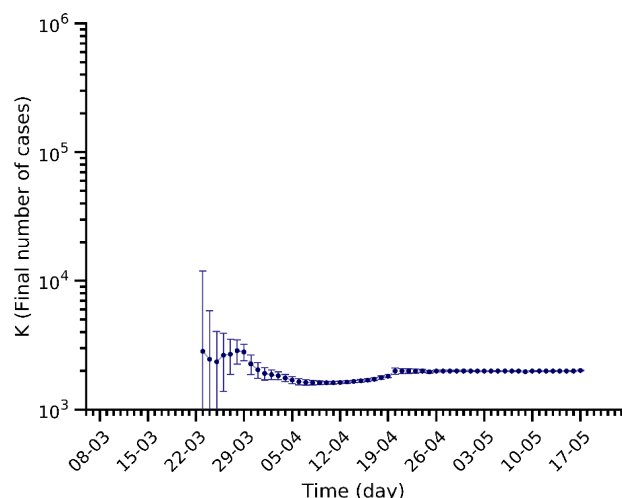
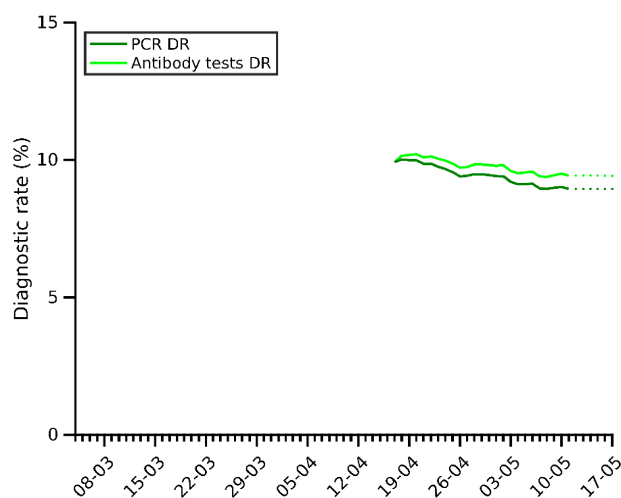
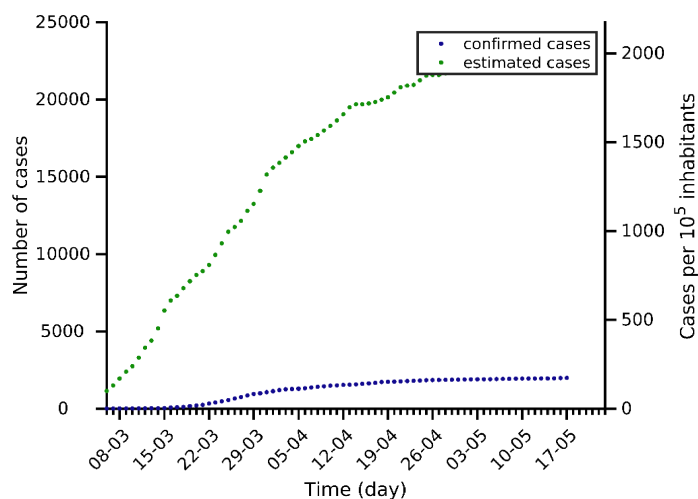
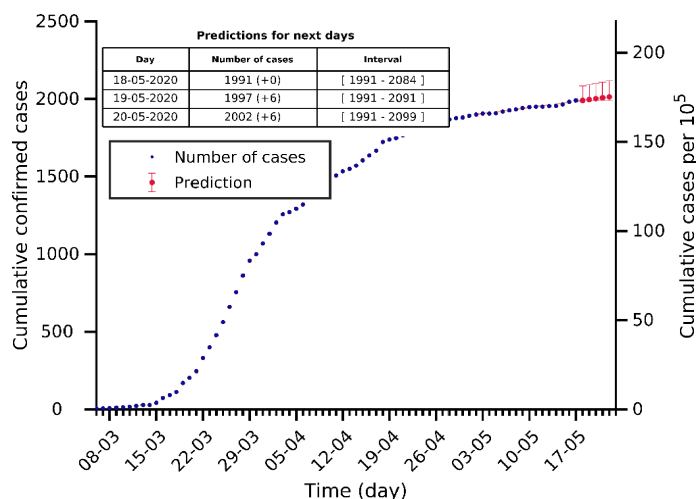
Canarias 17-05-2020. Population: 2.2M. Current cumulated incidence: 106/10⁵



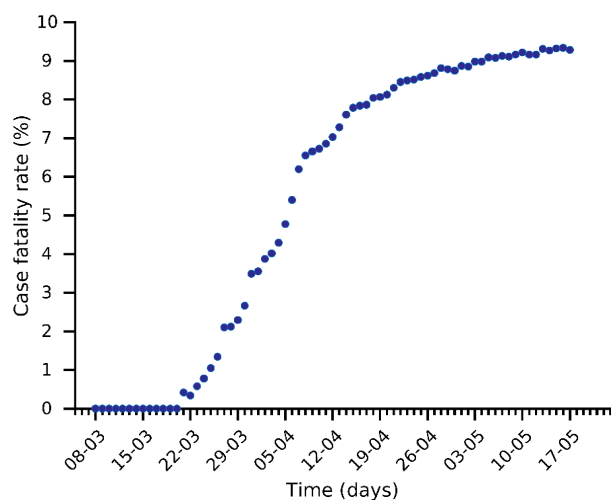
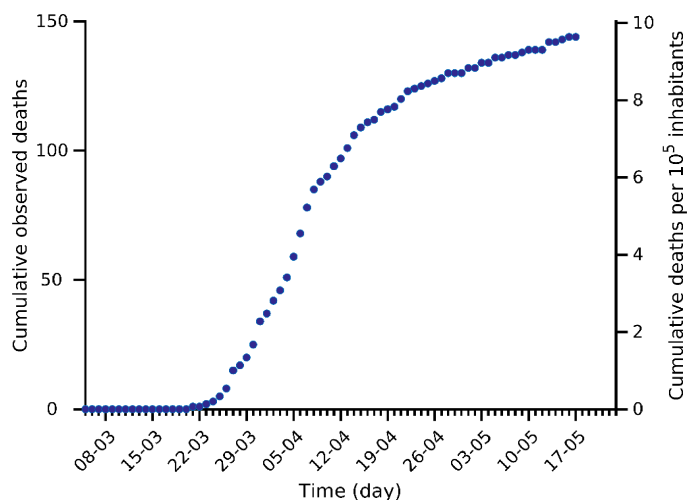
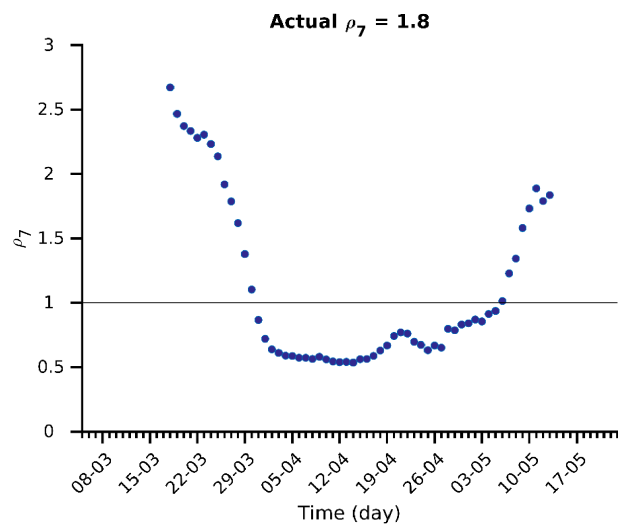
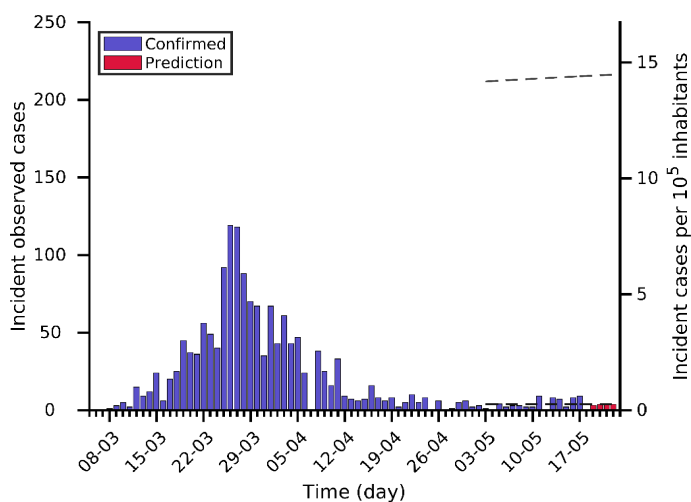
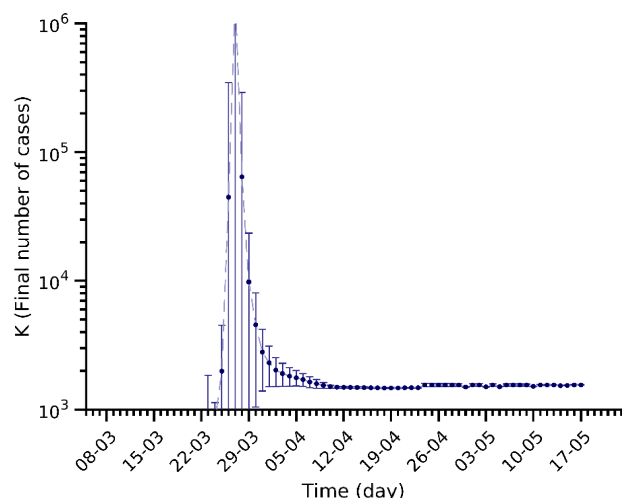
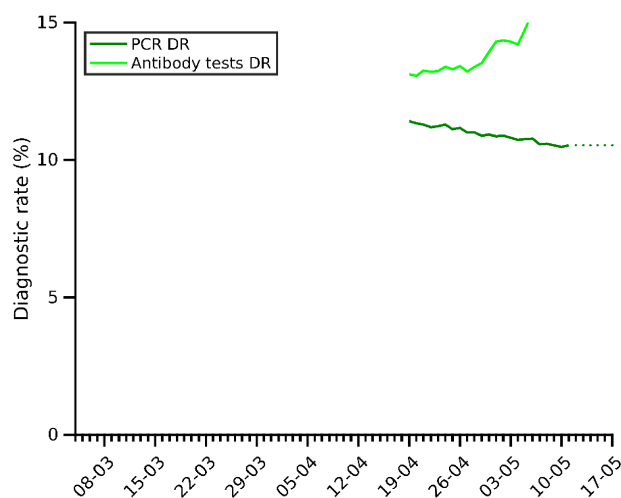
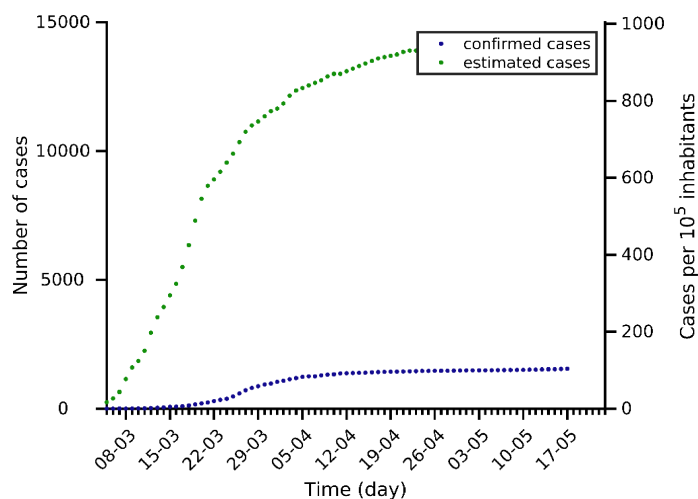
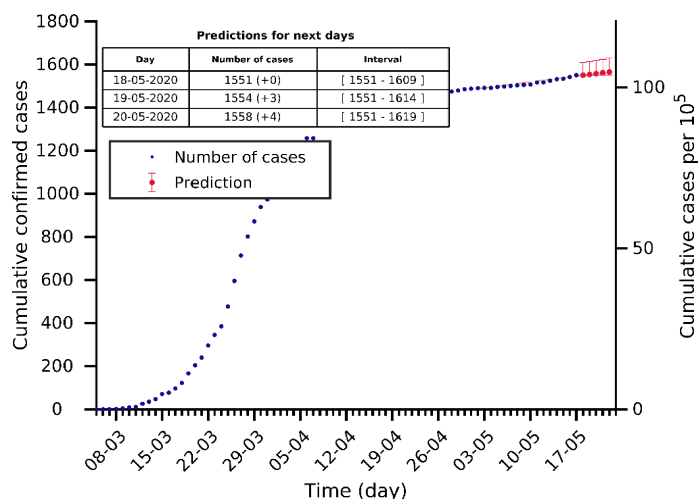
Cantabria 17-05-2020. Population: 0.6M. Current cumulated incidence: 390/10⁵



Baleares 17-05-2020. Population: 1.1M. Current cumulated incidence: 173/10⁵



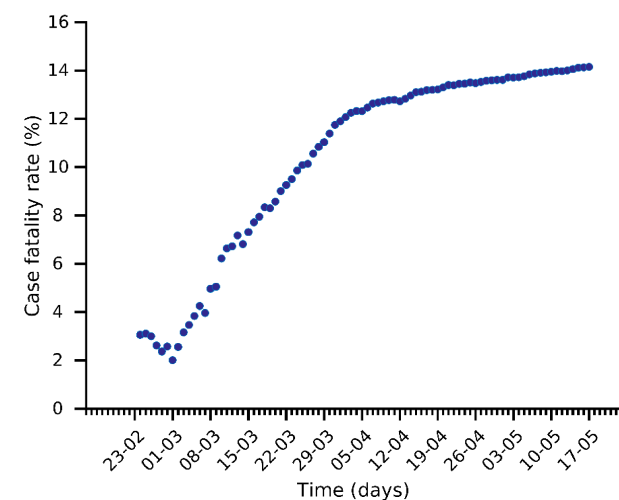
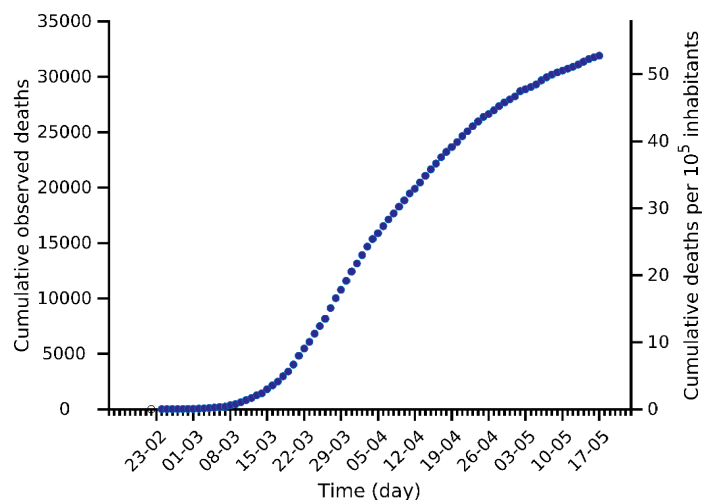
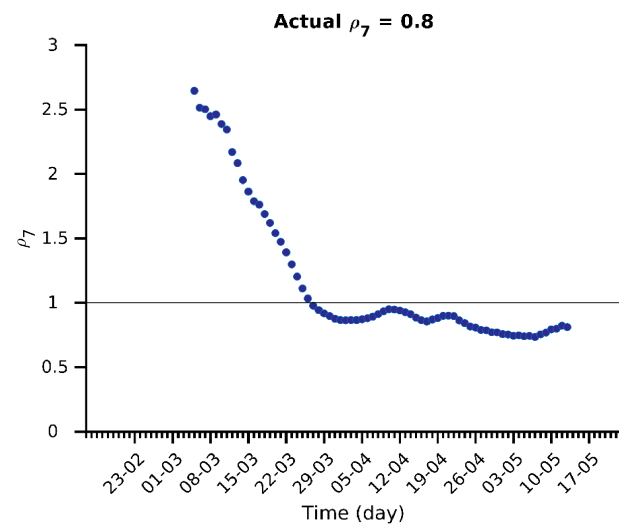
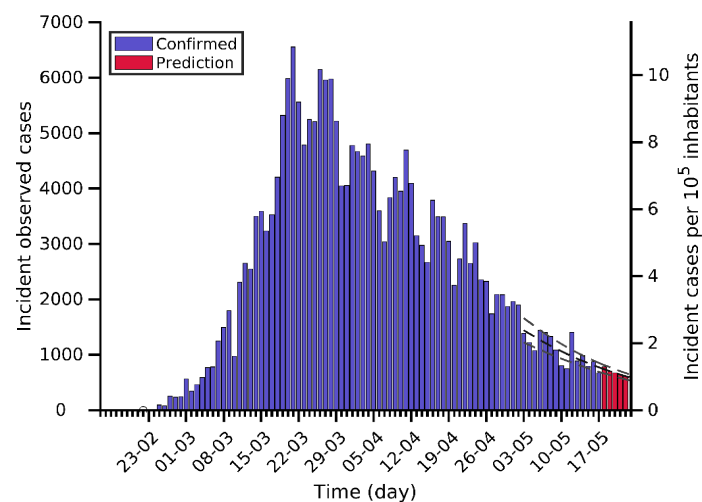
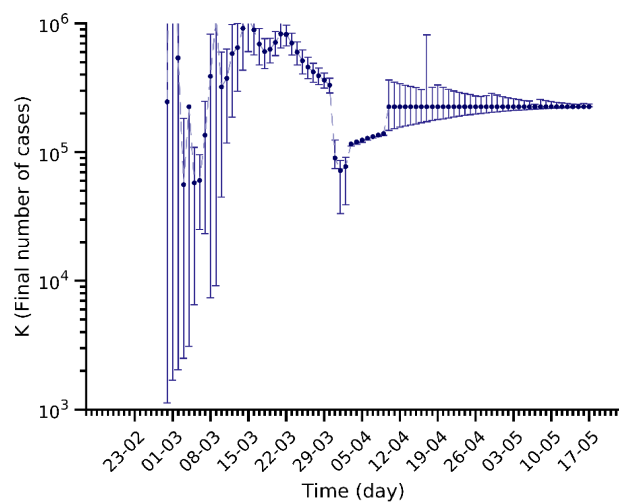
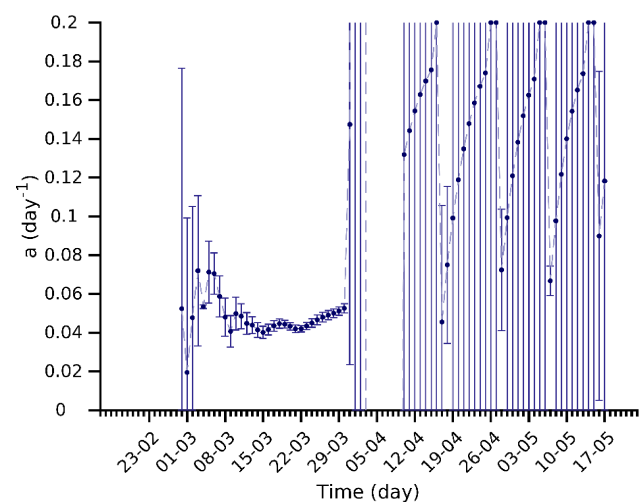
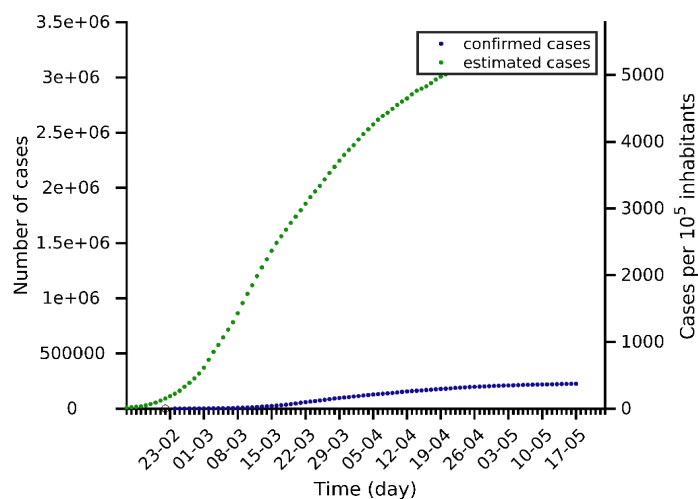
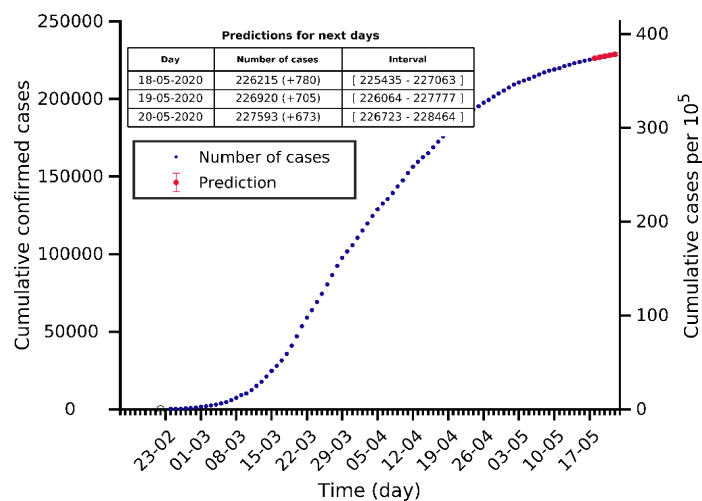
Murcia 17-05-2020. Population: 1.5M. Current cumulated incidence: 104/10⁵



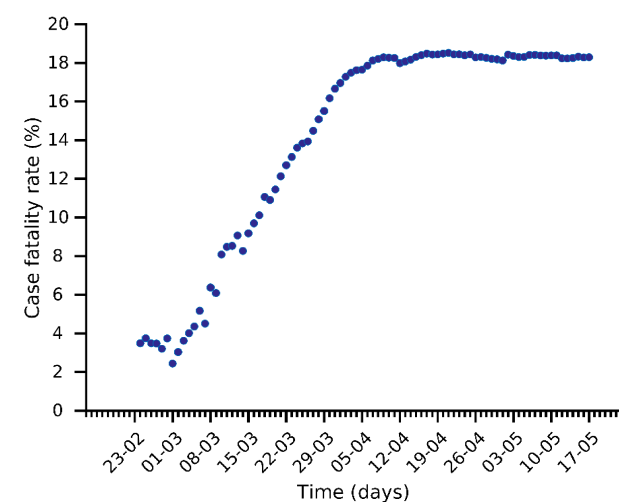
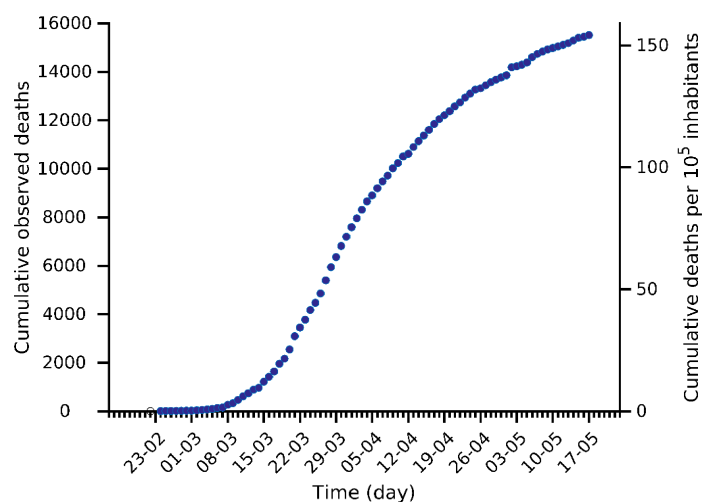
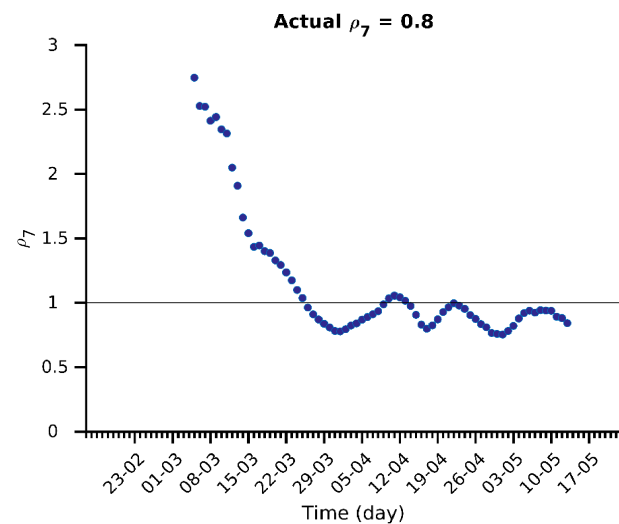
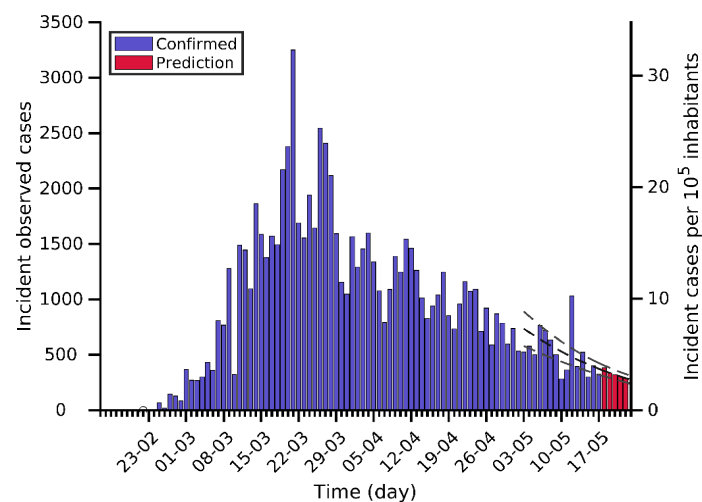
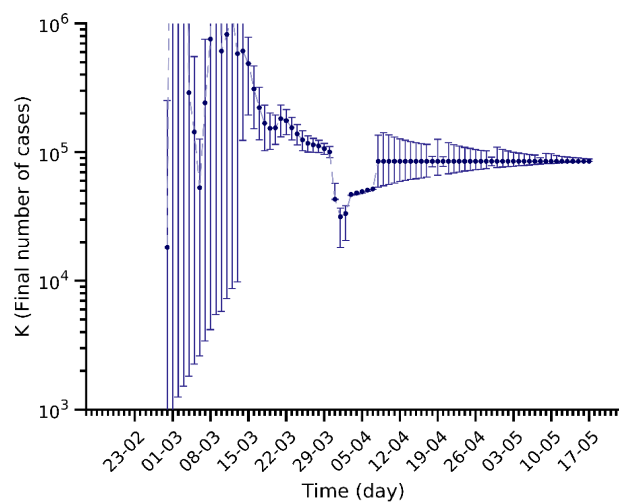
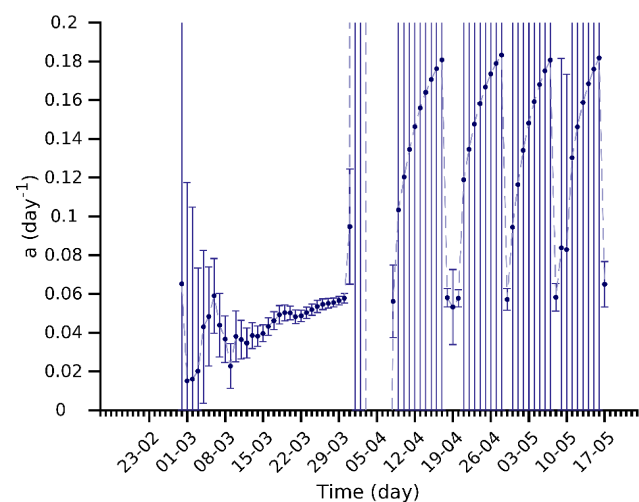
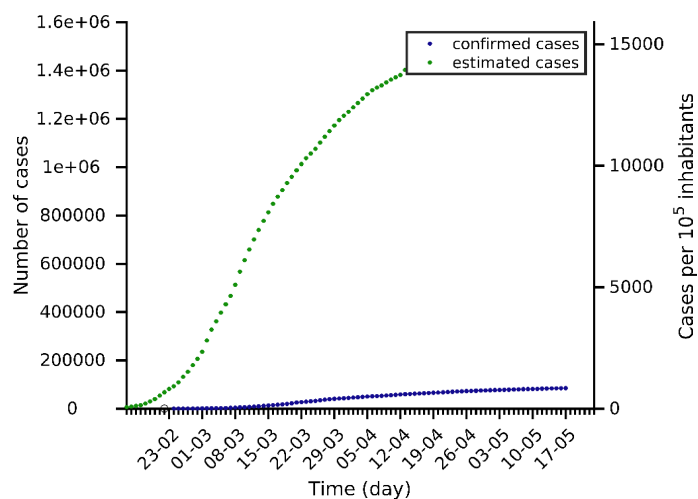
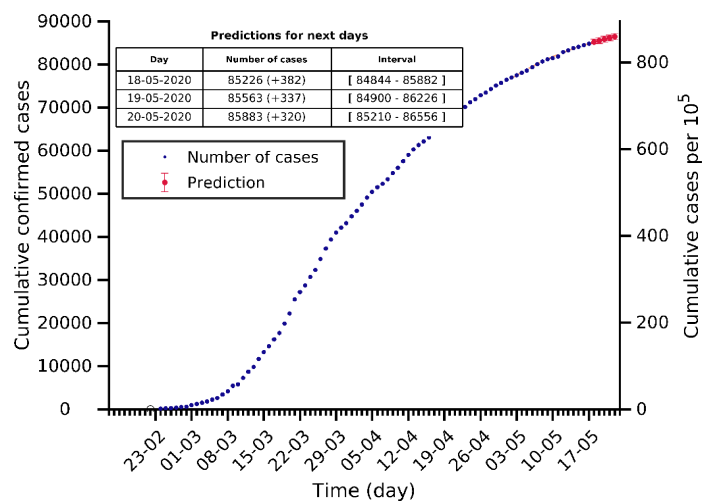
(4) Analysis and prediction of COVID-19 for Italy and its regions

Data obtained from: <https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale>

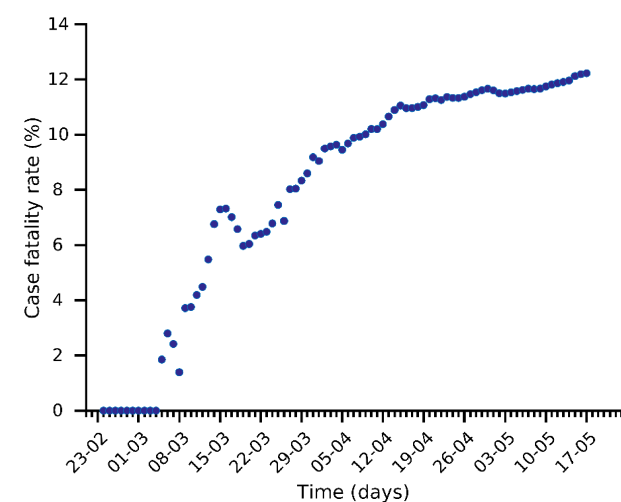
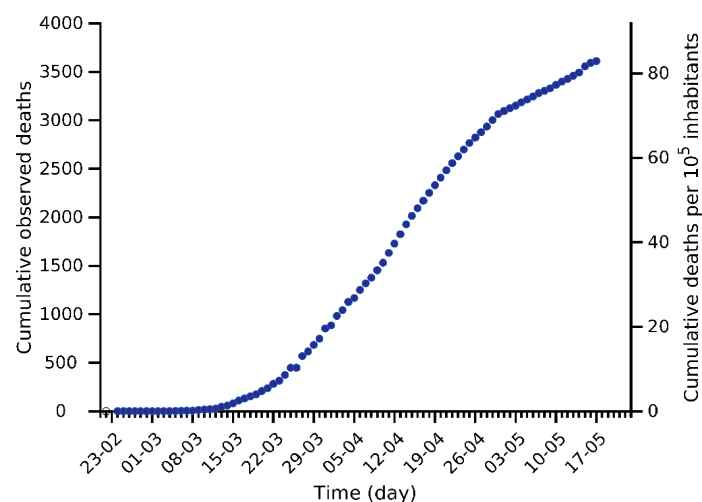
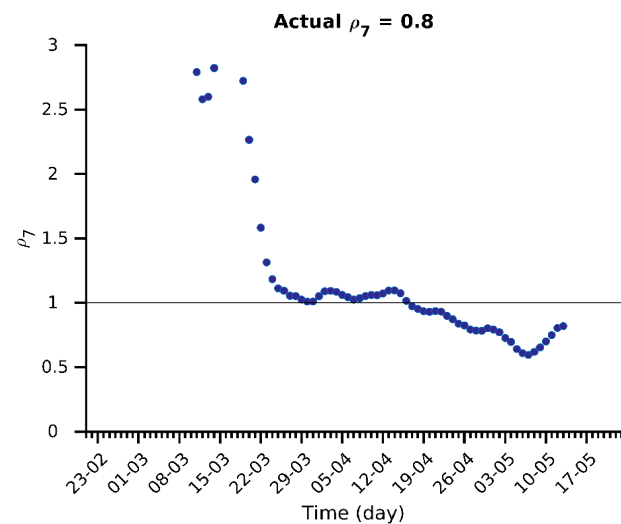
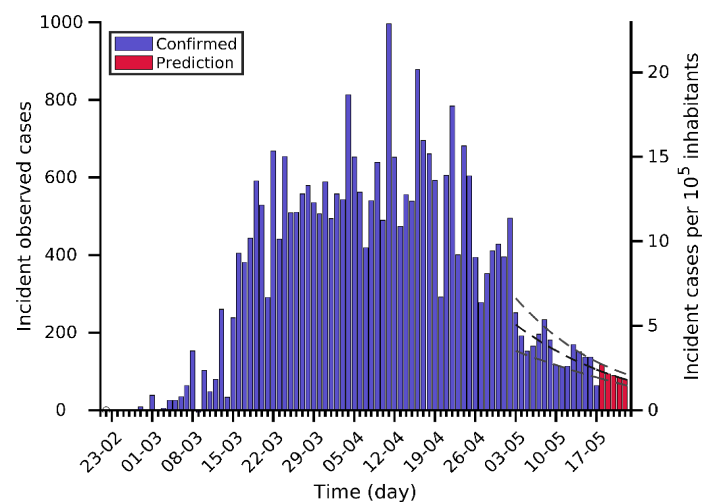
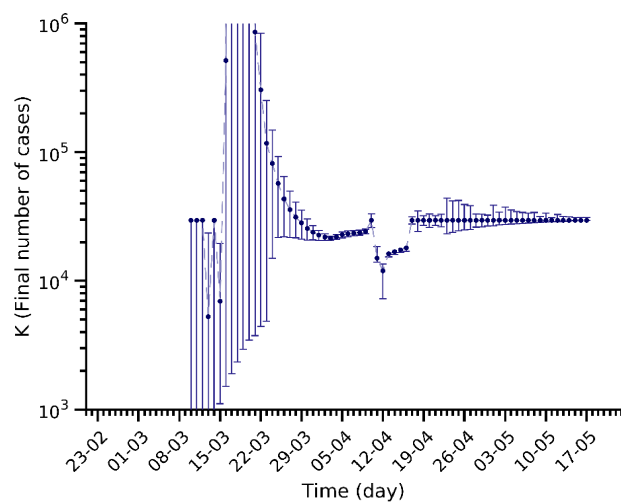
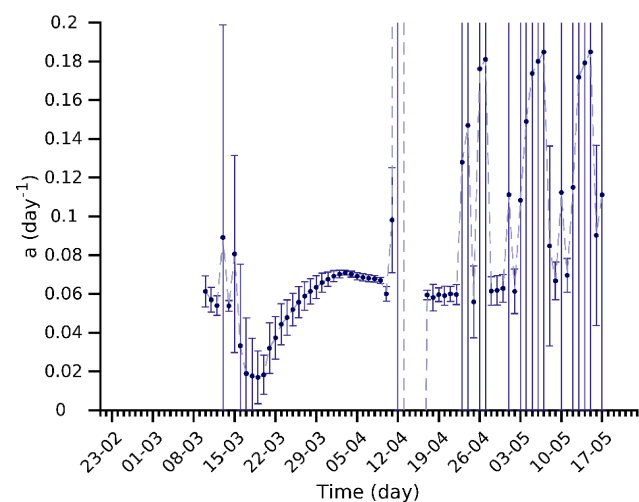
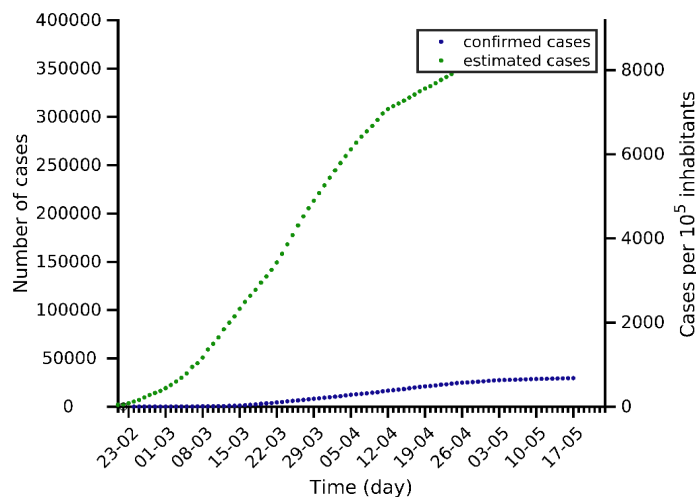
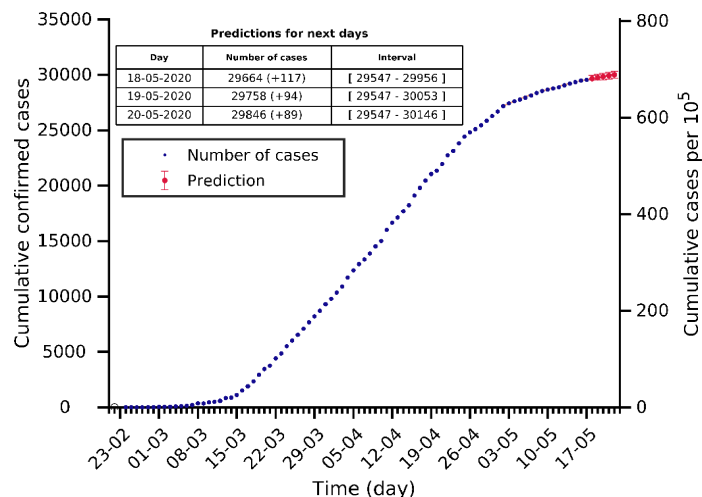
Italy 17-05-2020. Population: 60.5M. Current cumulated incidence: 373/10⁵



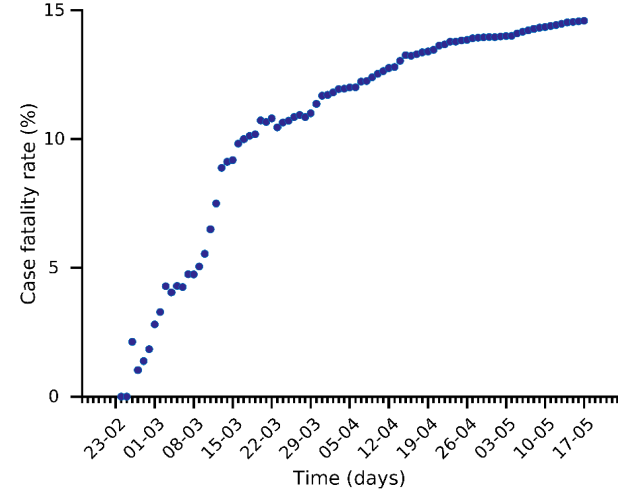
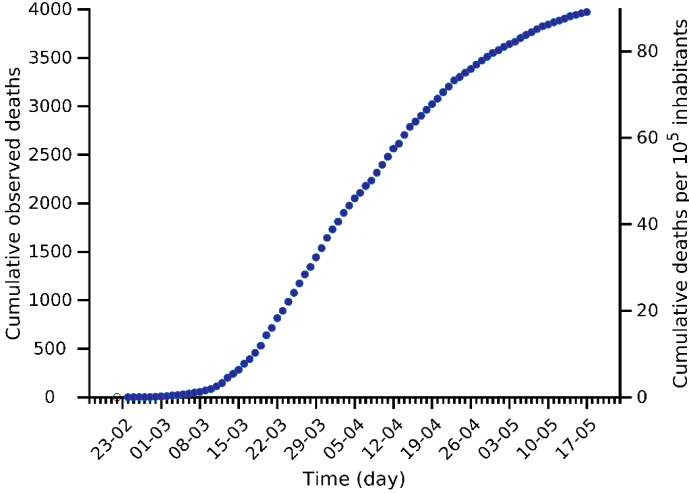
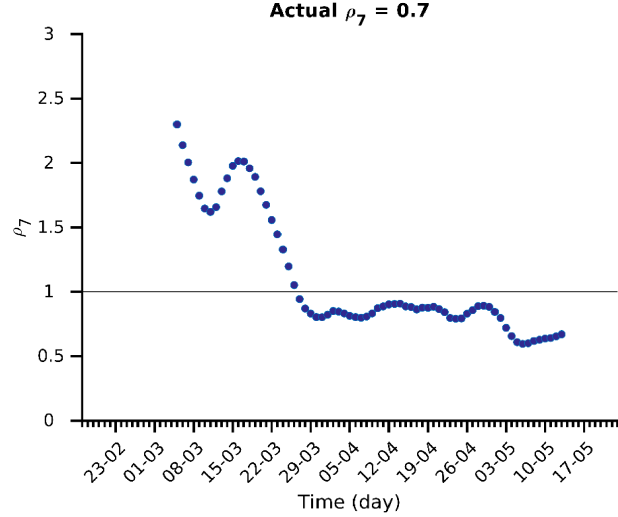
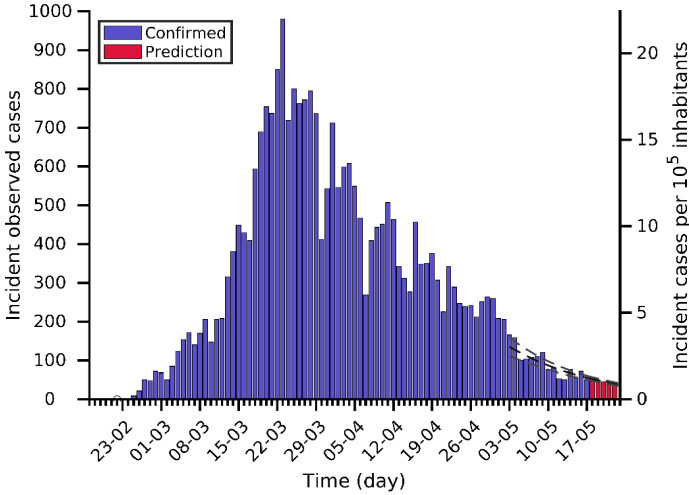
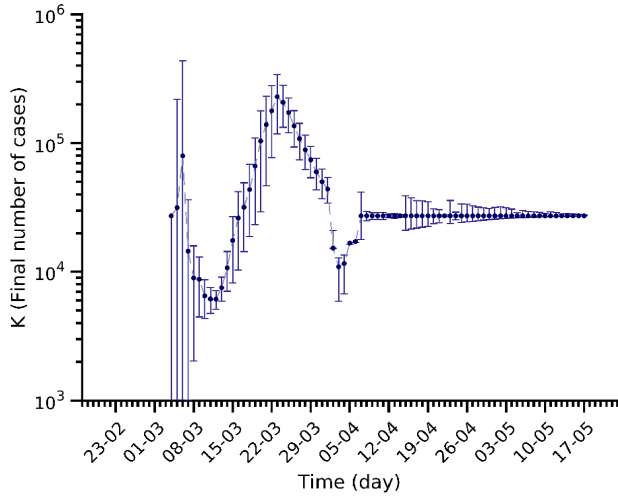
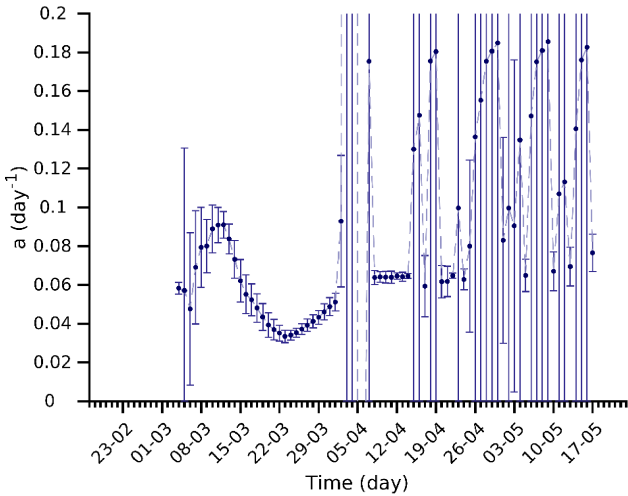
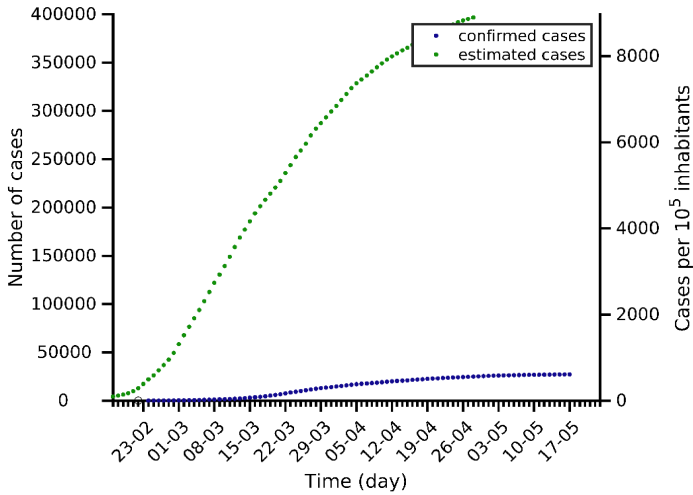
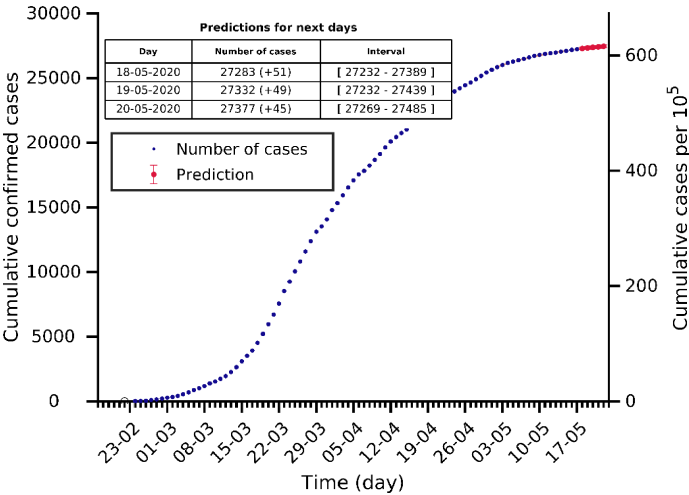
Lombardia 17-05-2020. Population: 10.1M. Current cumulated incidence: 843/10⁵



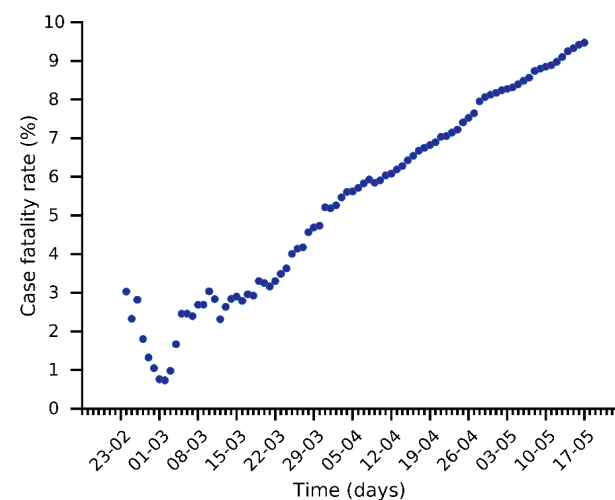
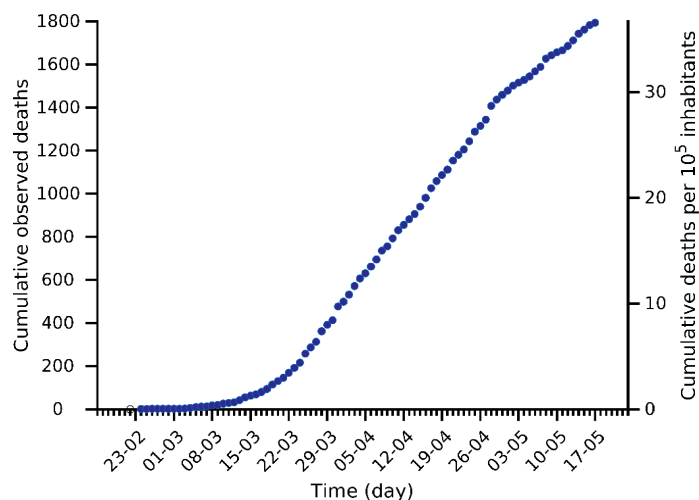
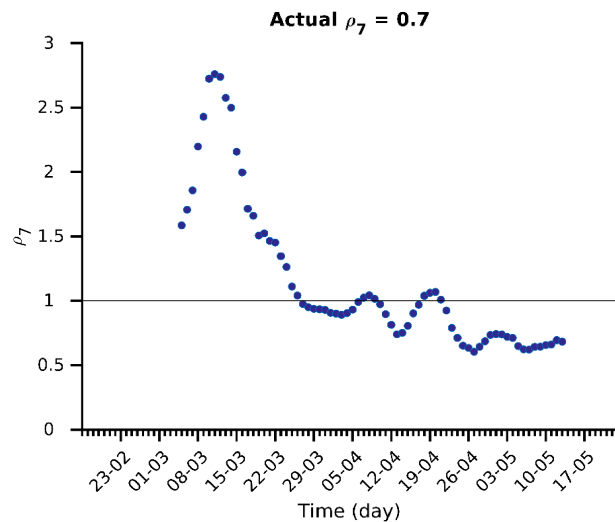
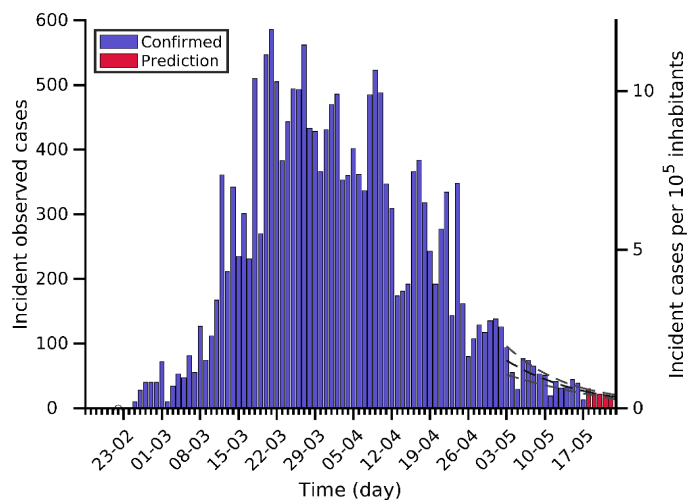
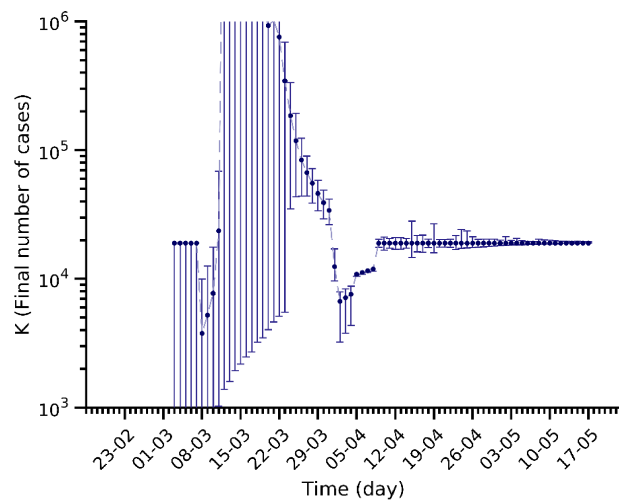
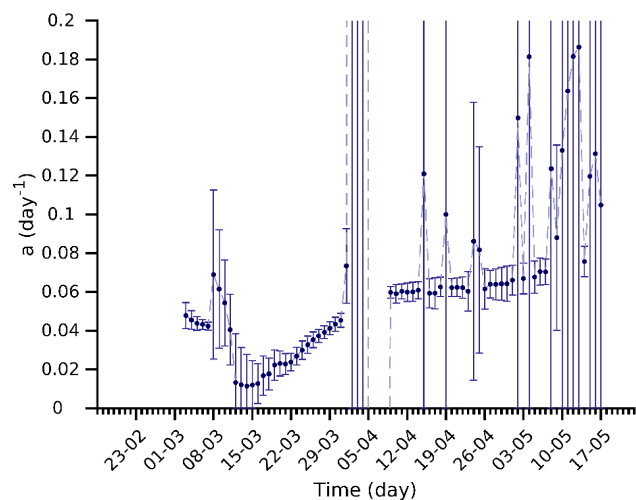
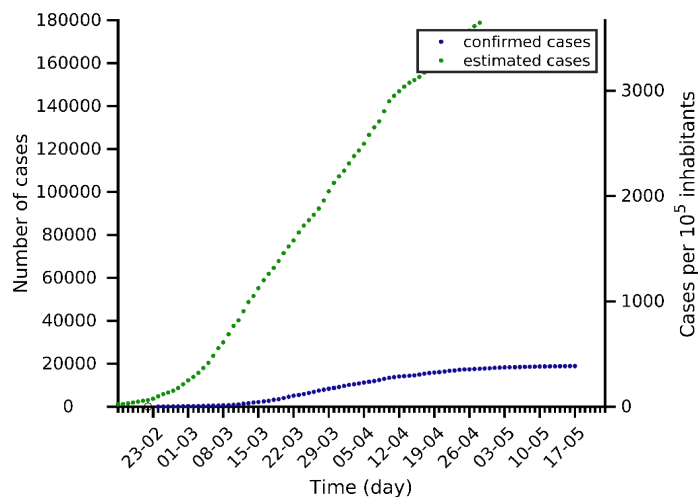
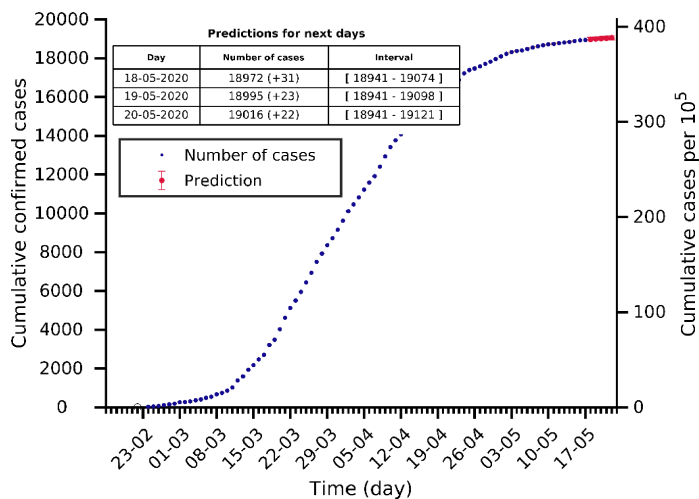
Piemonte 17-05-2020. Population: 4.4M. Current cumulated incidence: 678/10⁵



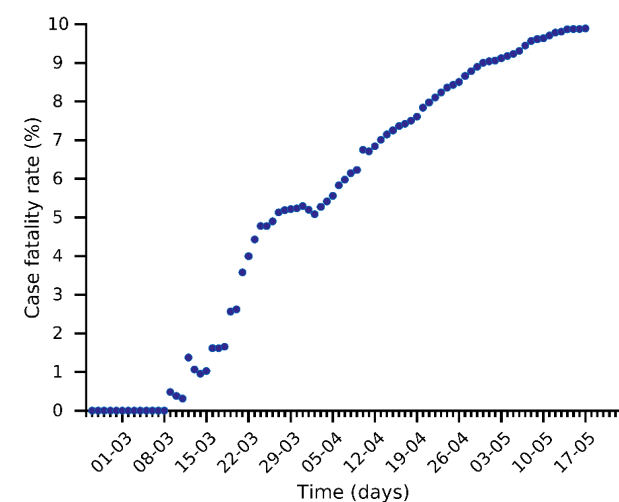
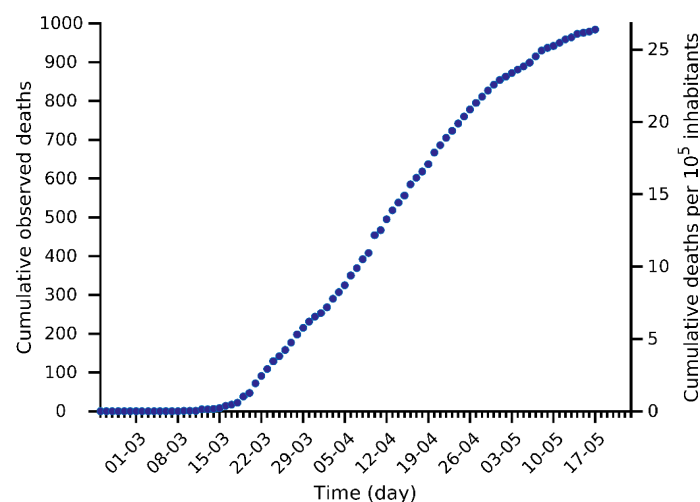
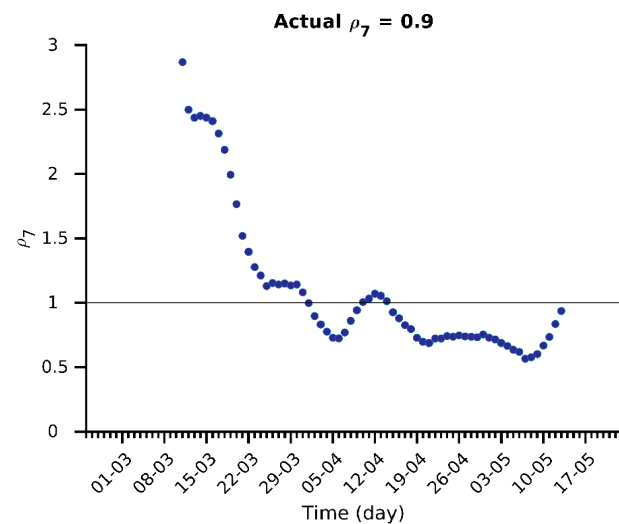
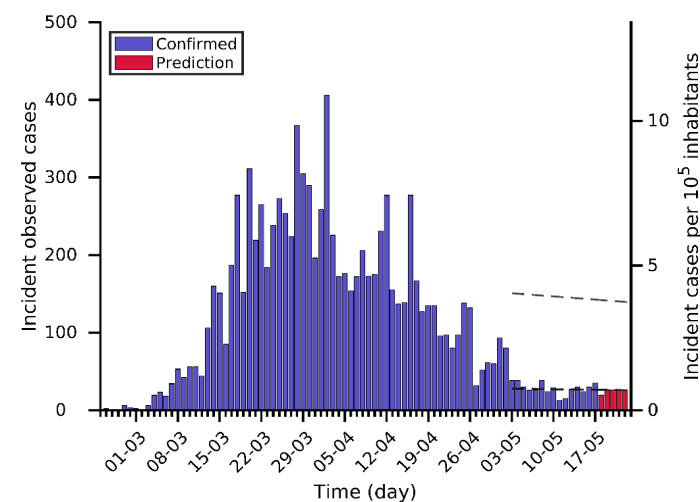
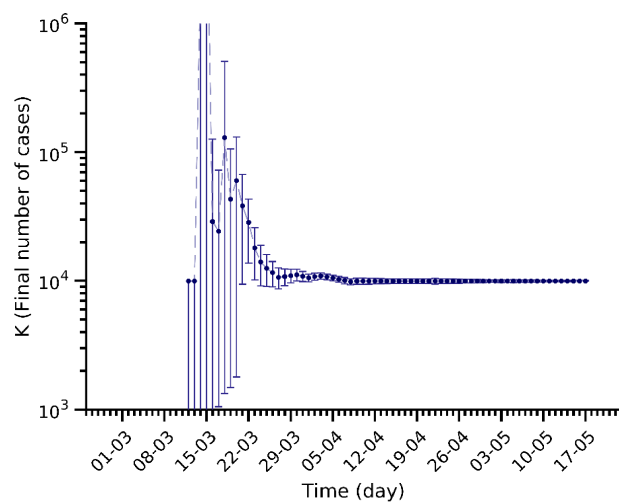
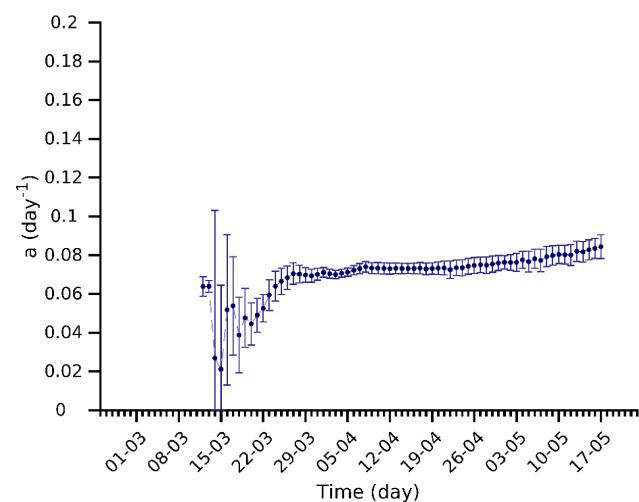
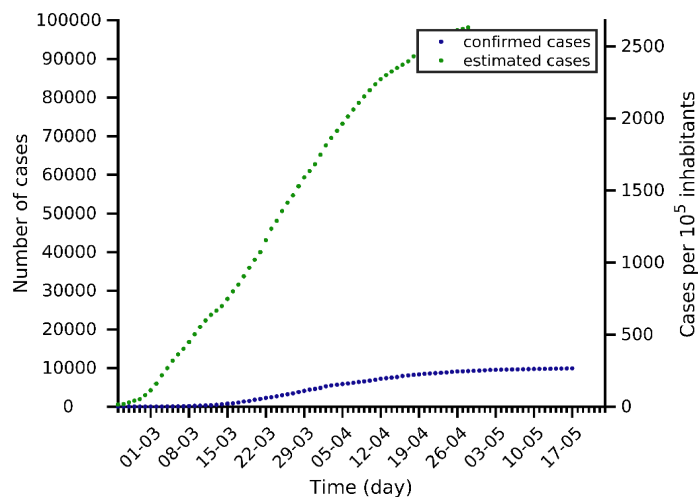
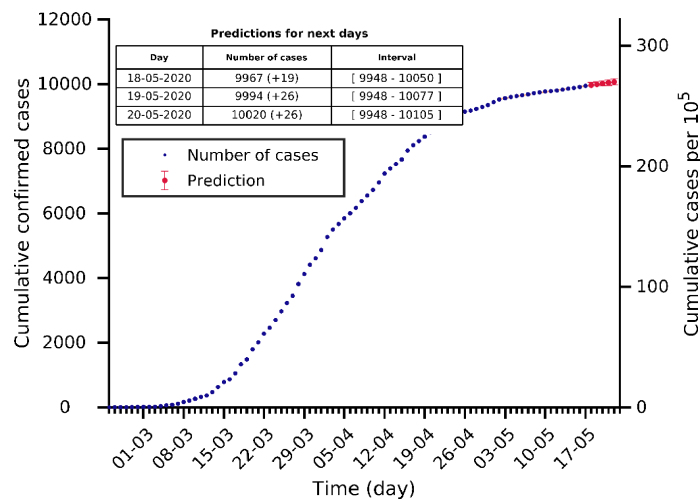
Emilia Romagna 17-05-2020. Population: 4.5M. Current cumulated incidence: 611/100000



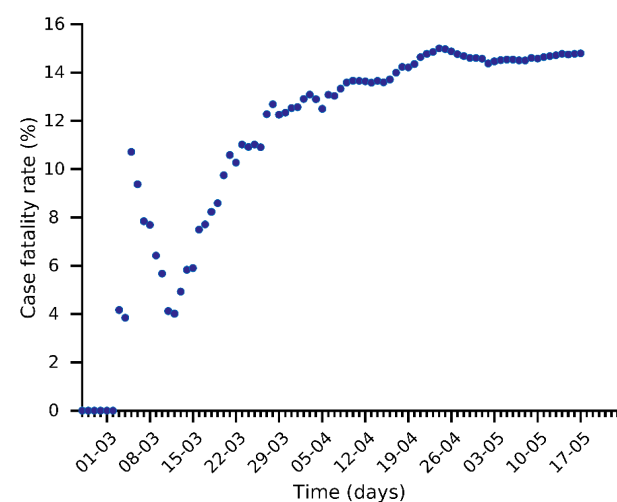
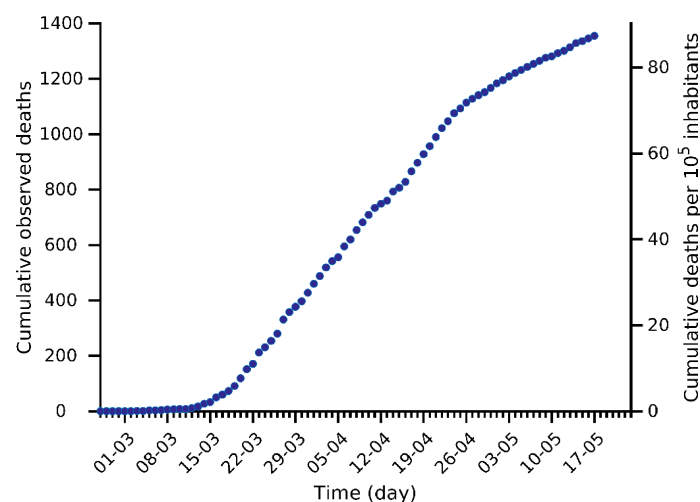
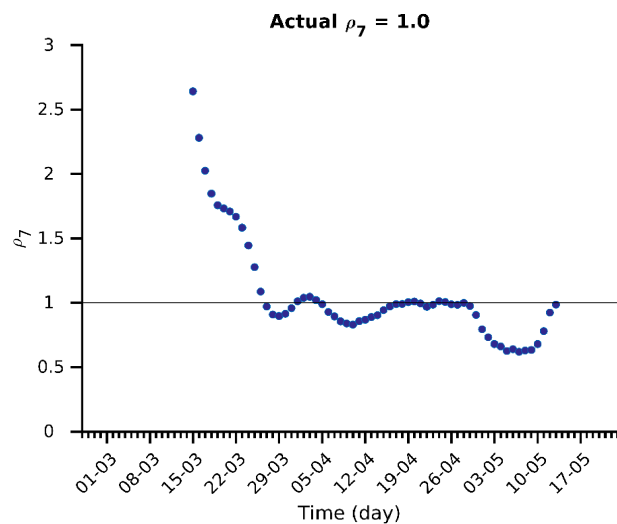
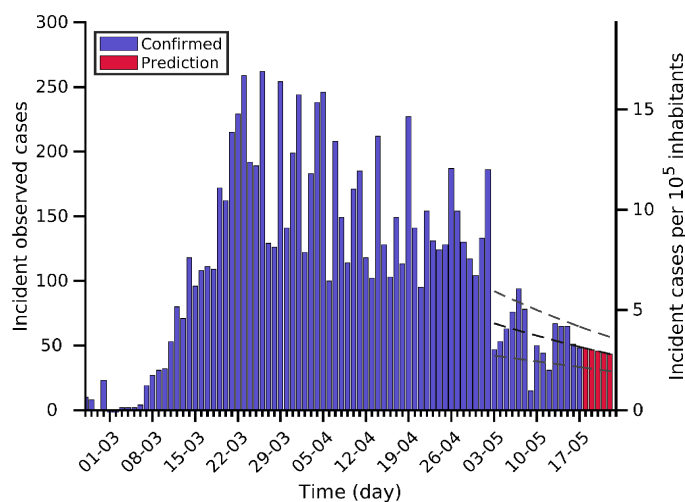
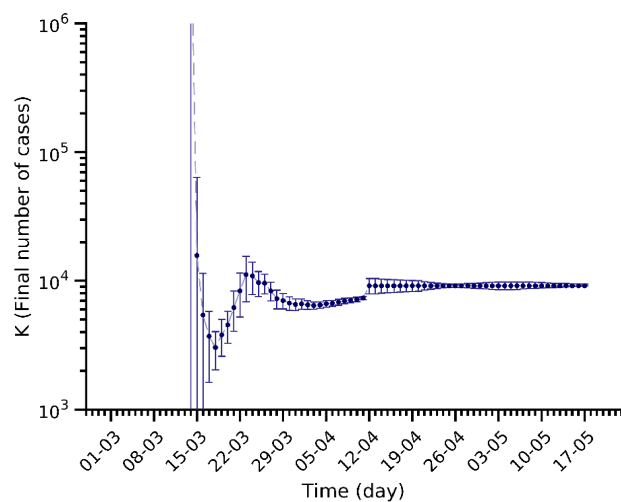
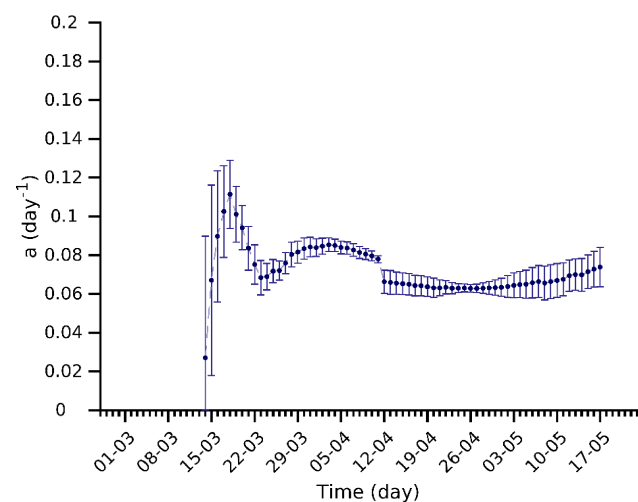
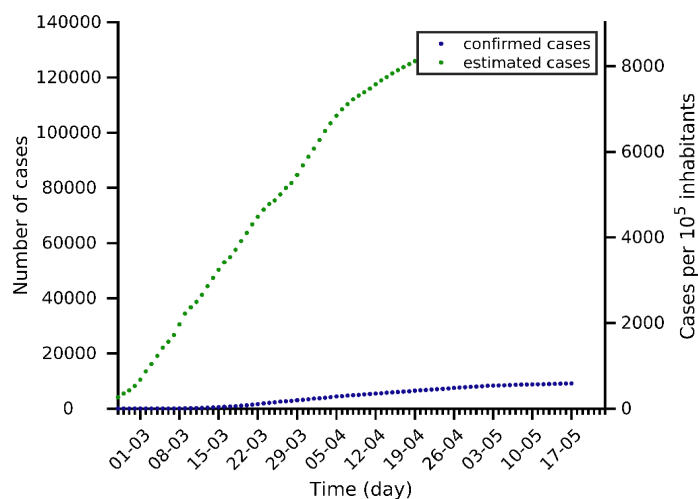
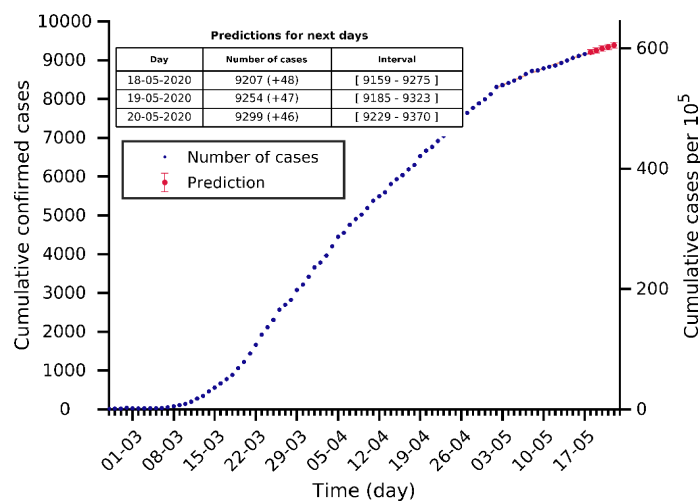
Veneto 17-05-2020. Population: 4.9M. Current cumulated incidence: 386/10⁵



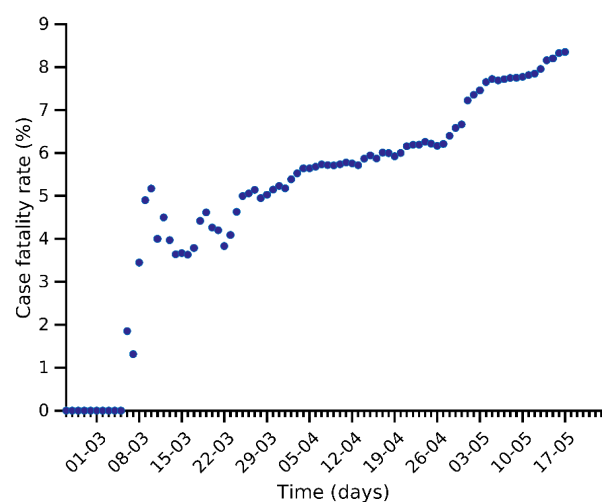
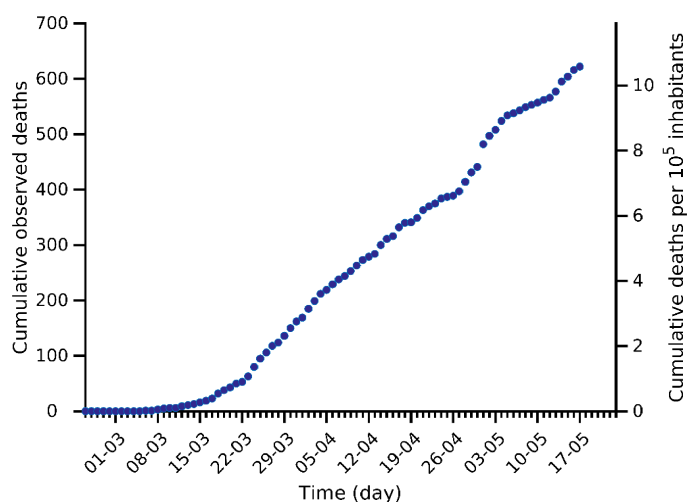
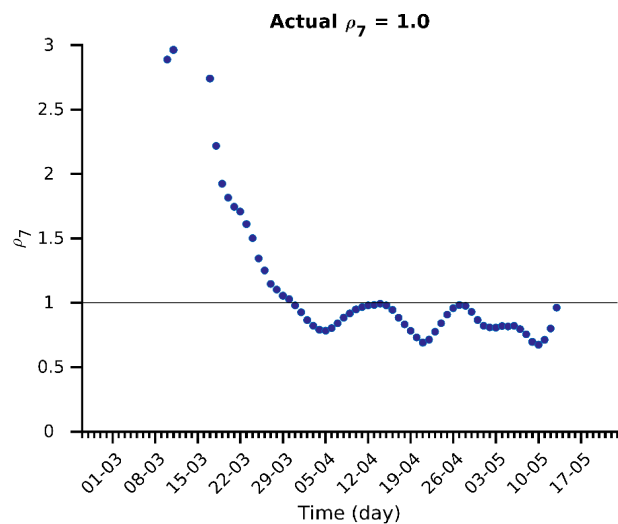
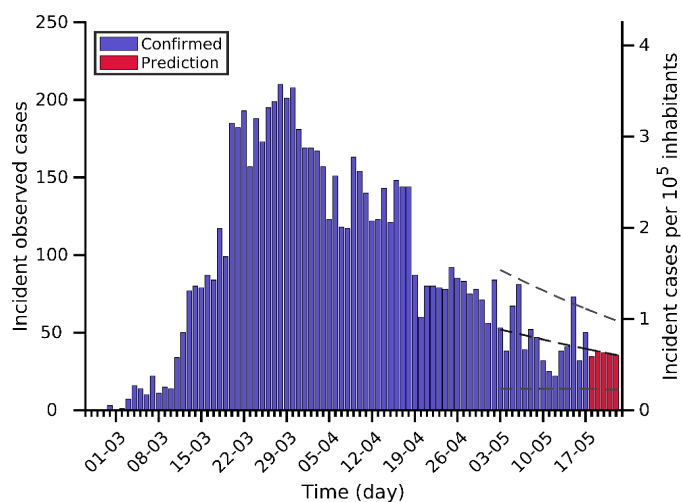
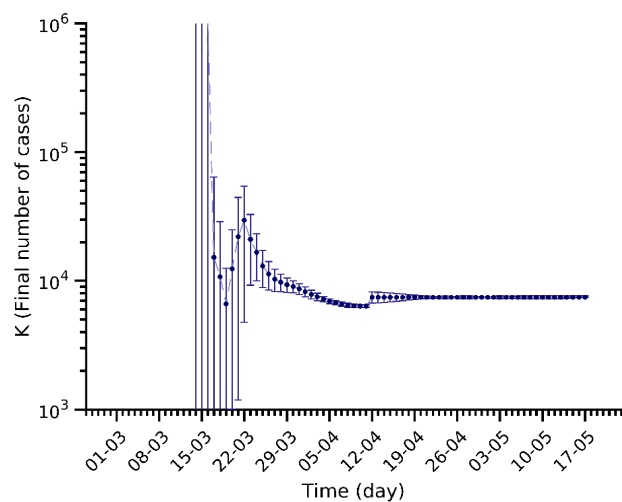
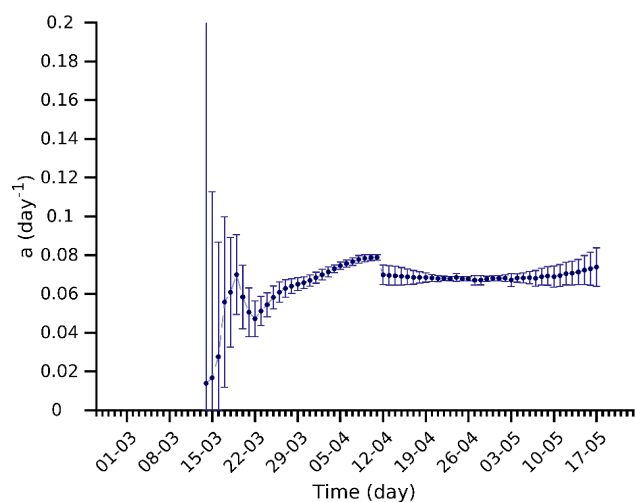
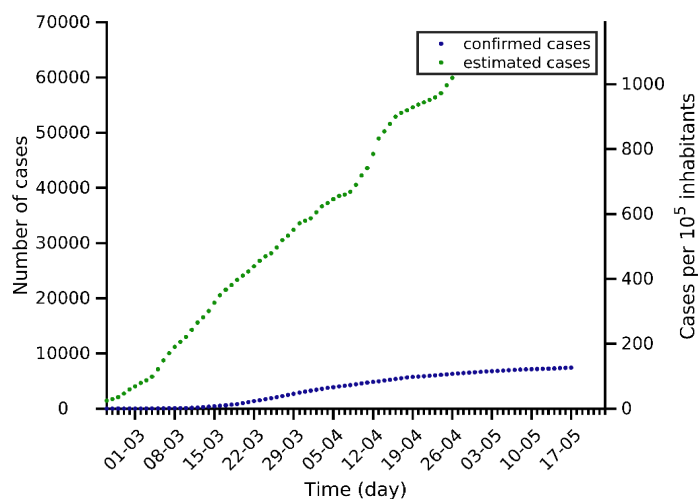
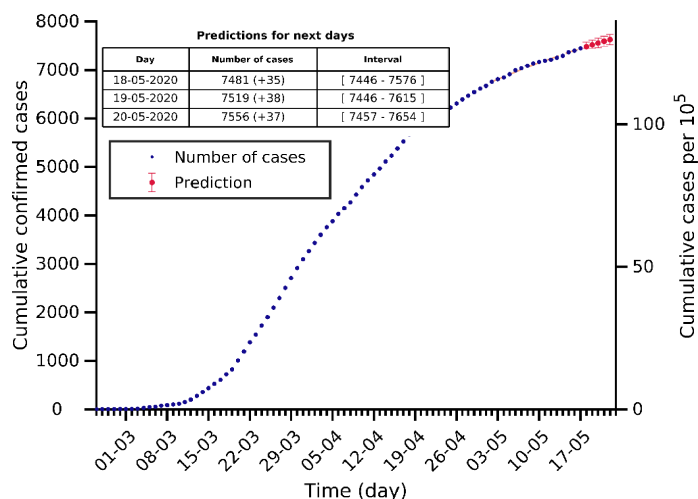
Toscana 17-05-2020. Population: 3.7M. Current cumulated incidence: 267/10⁵



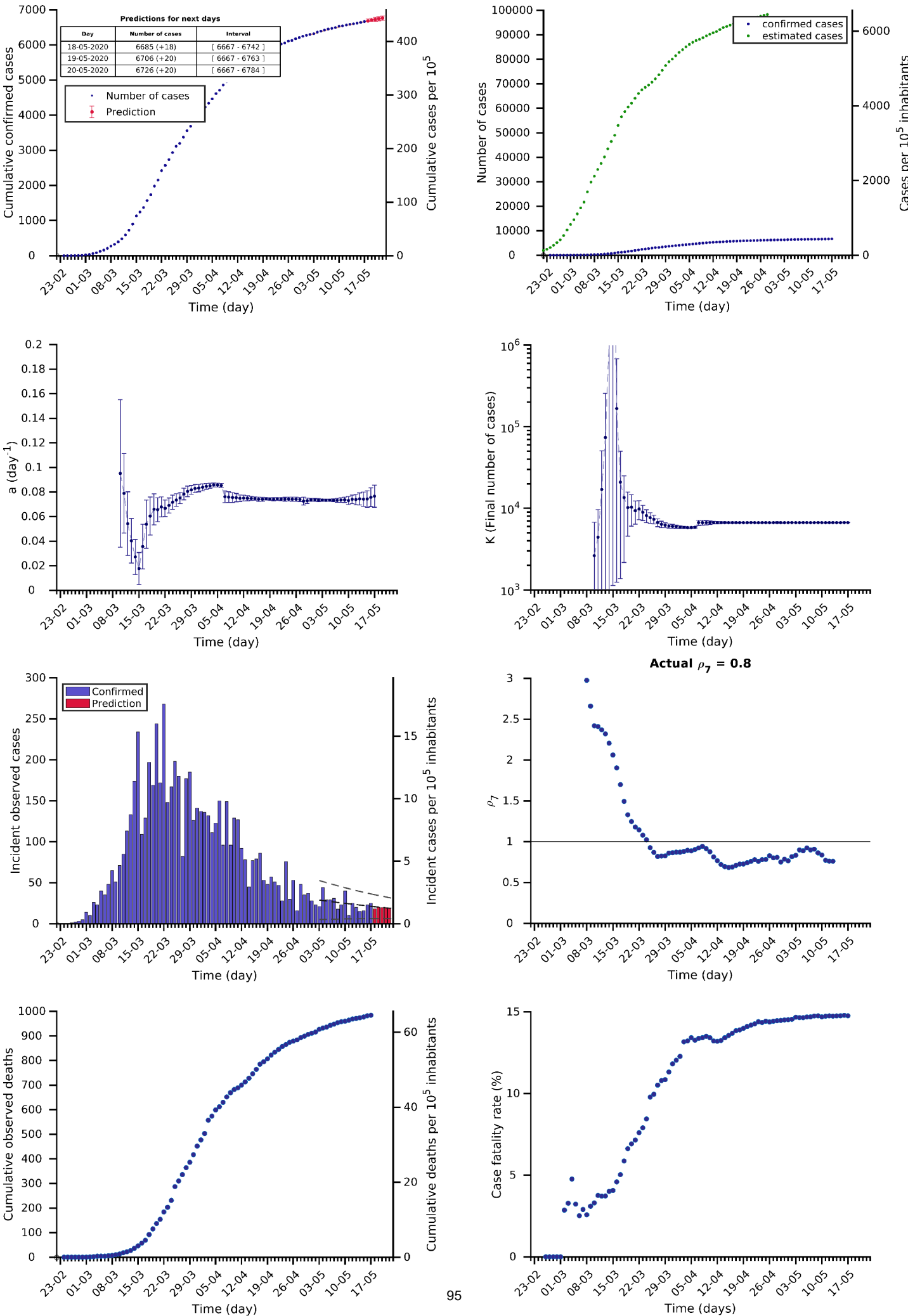
Liguria 17-05-2020. Population: 1.6M. Current cumulated incidence: 591/10⁵



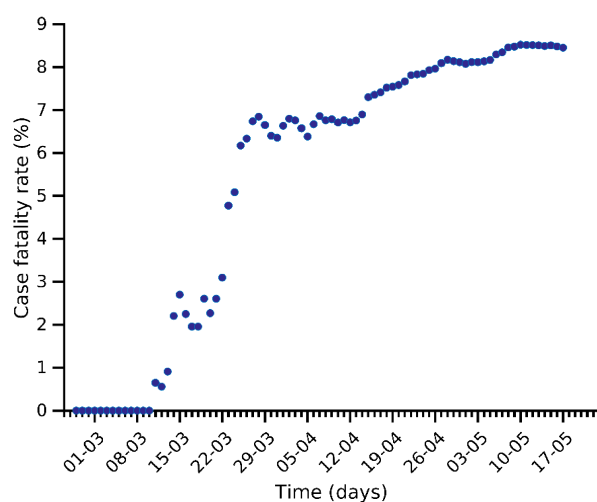
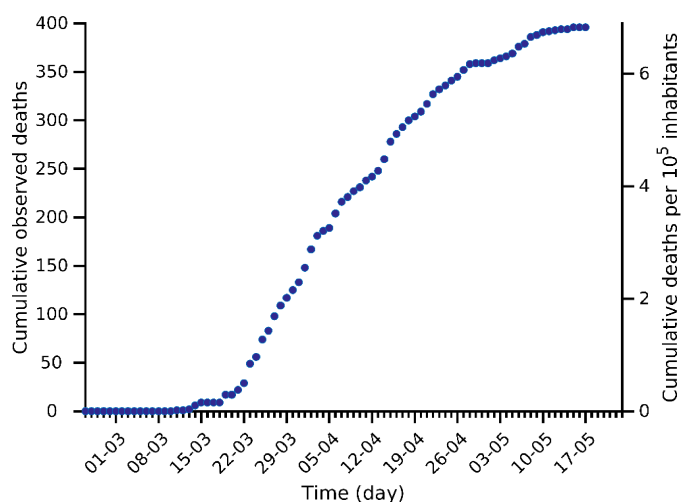
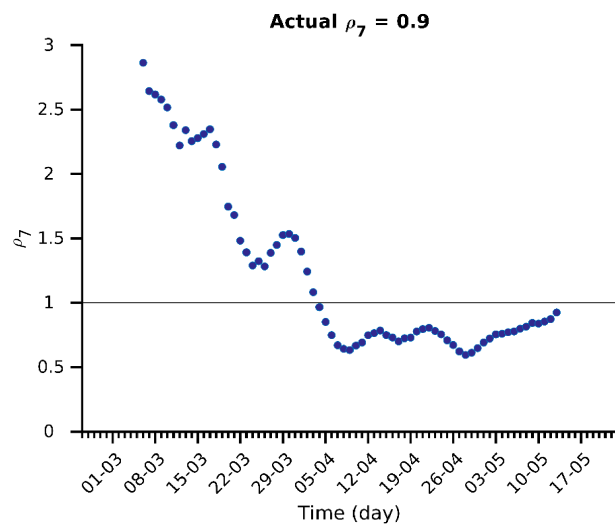
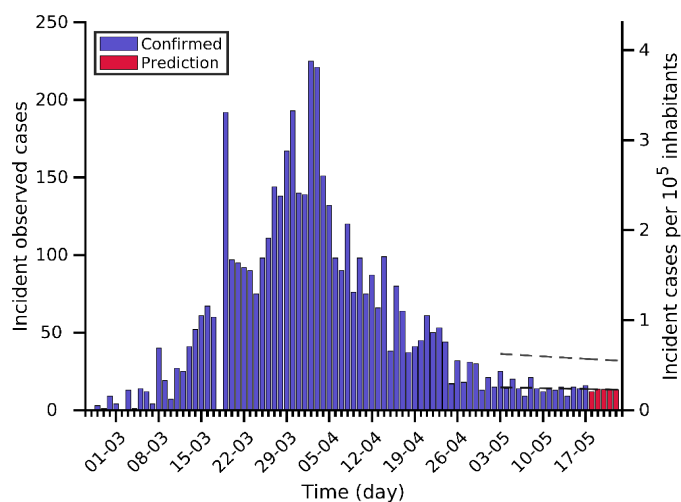
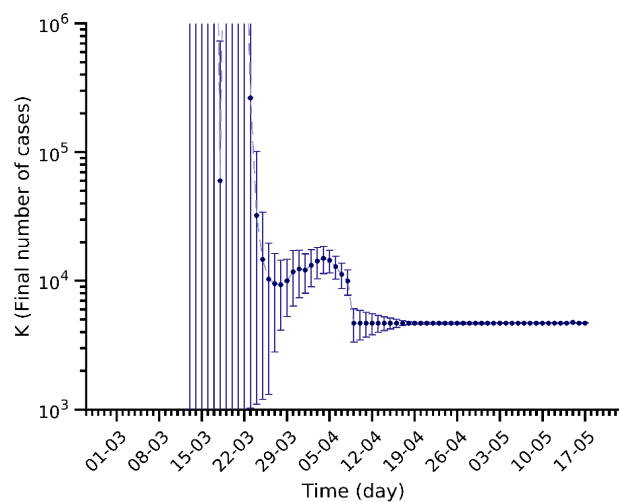
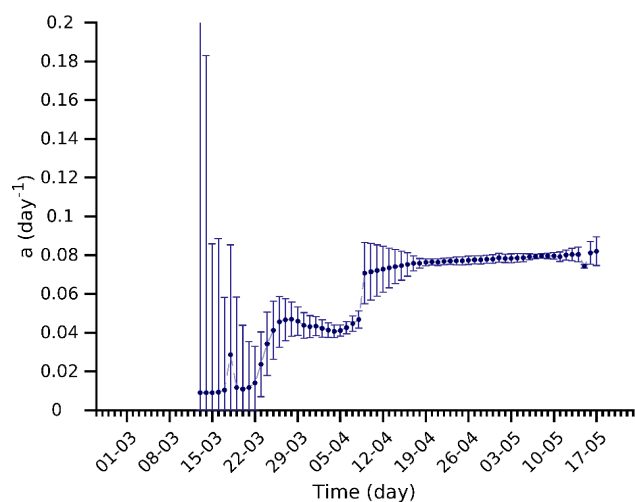
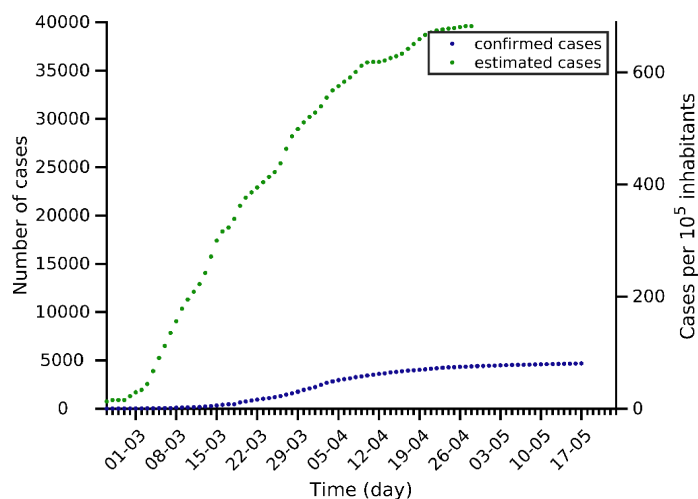
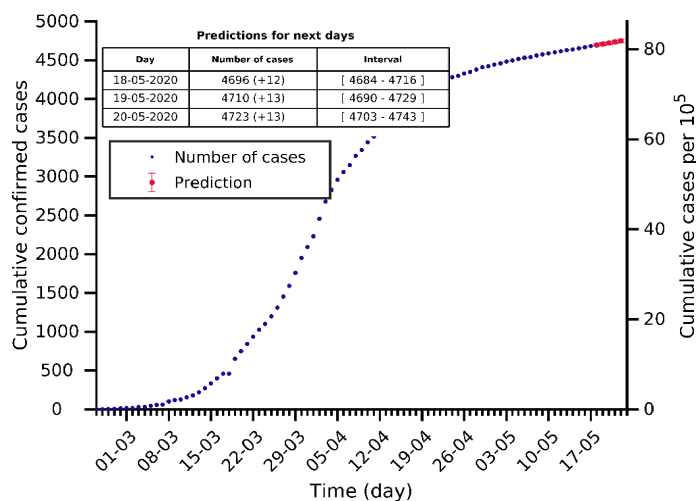
Lazio 17-05-2020. Population: 5.9M. Current cumulated incidence: 127/10⁵



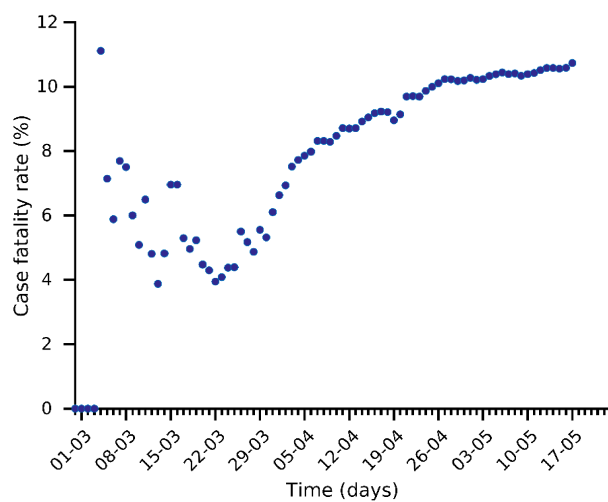
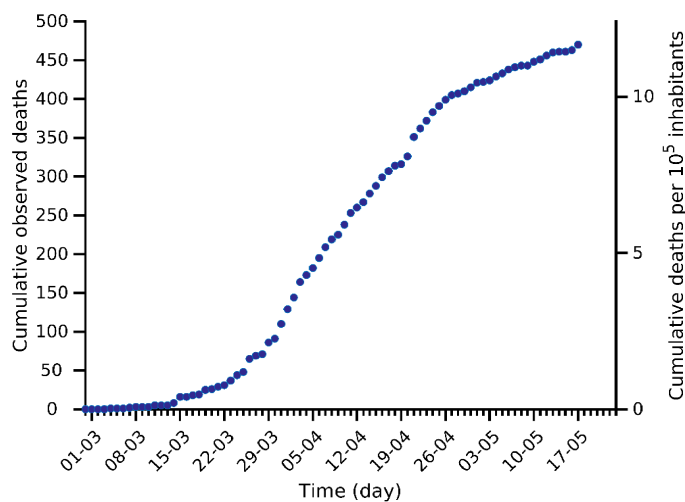
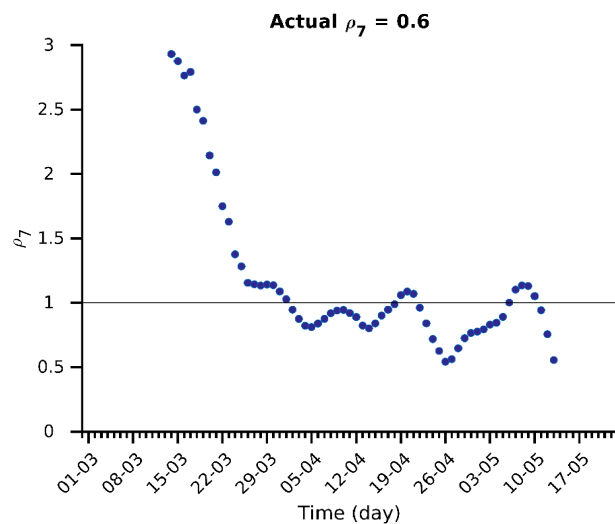
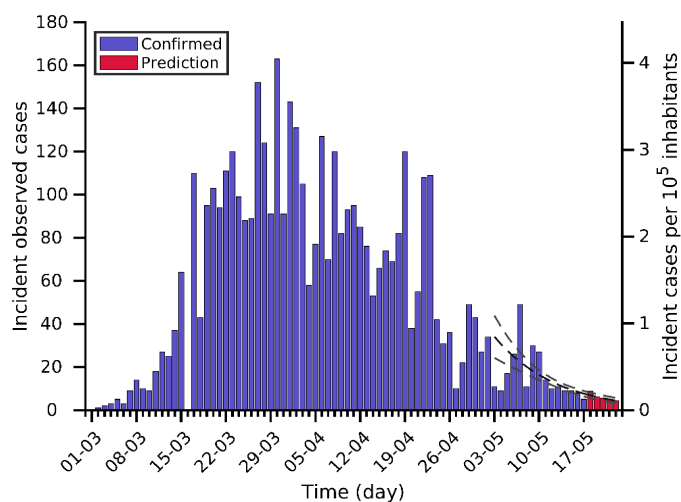
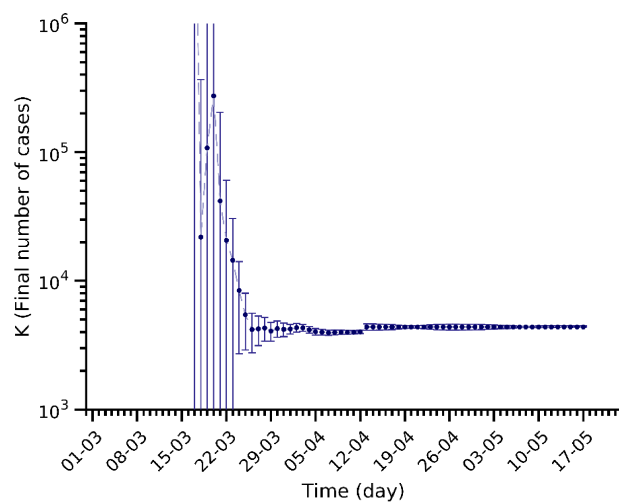
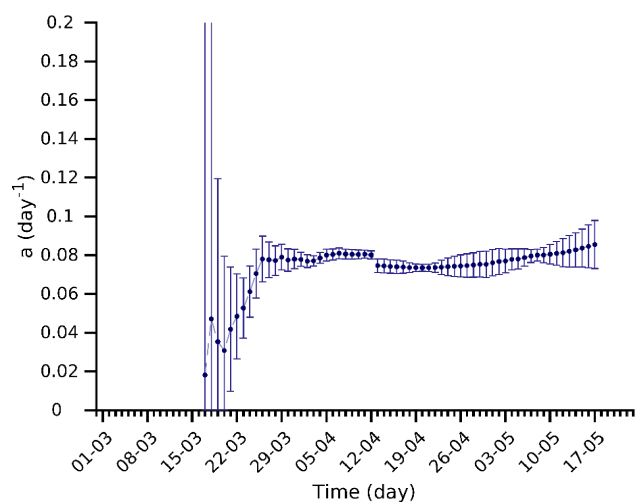
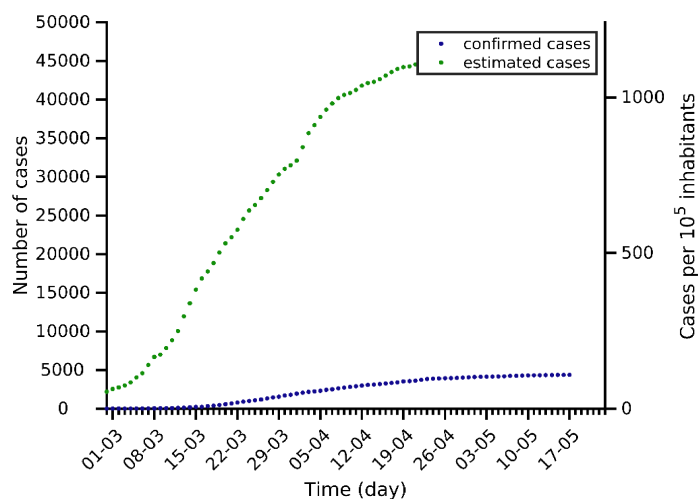
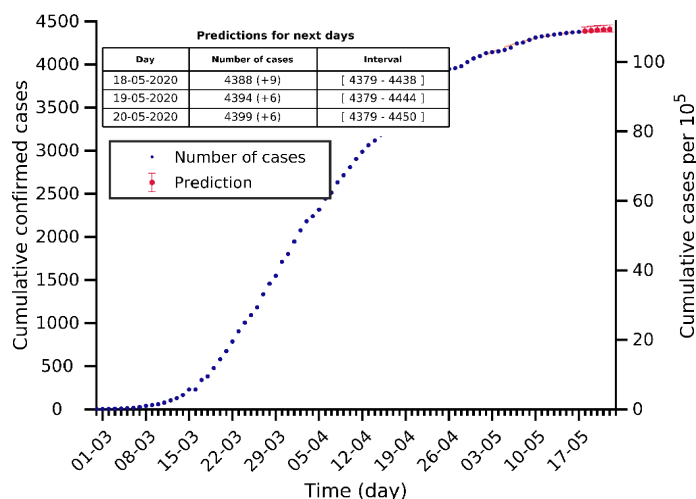
Marche
 17-05-2020.
 Population: 1.5M.
 Current cumulated incidence: 437/10⁵



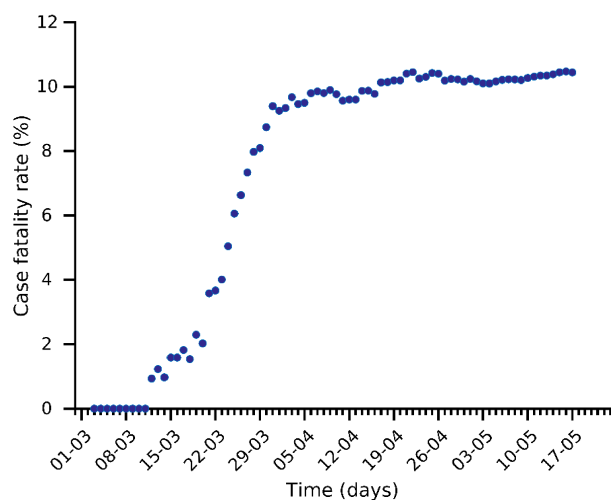
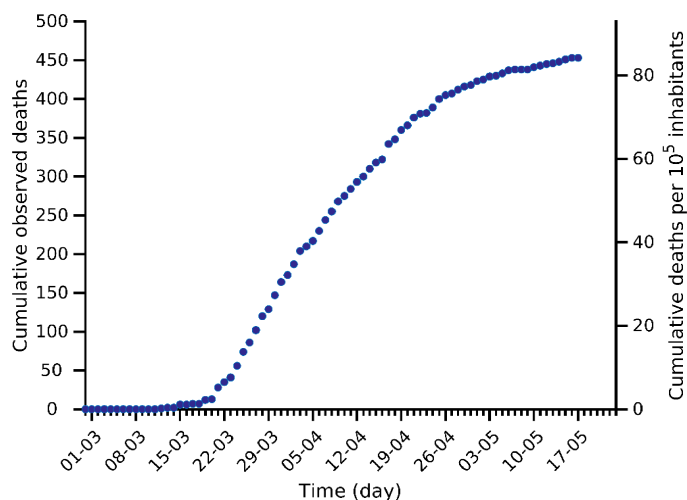
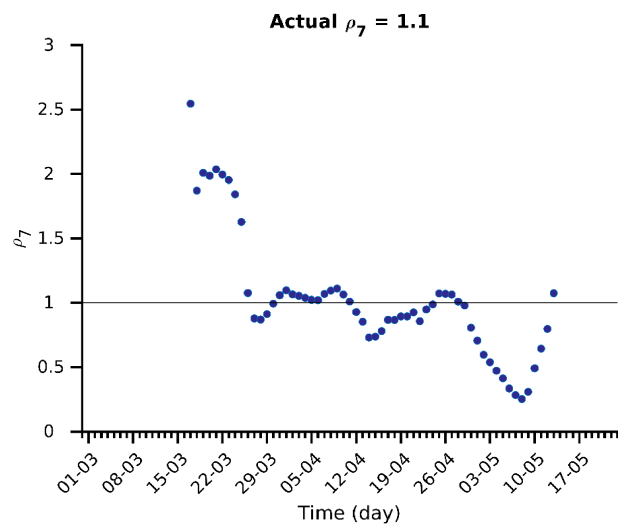
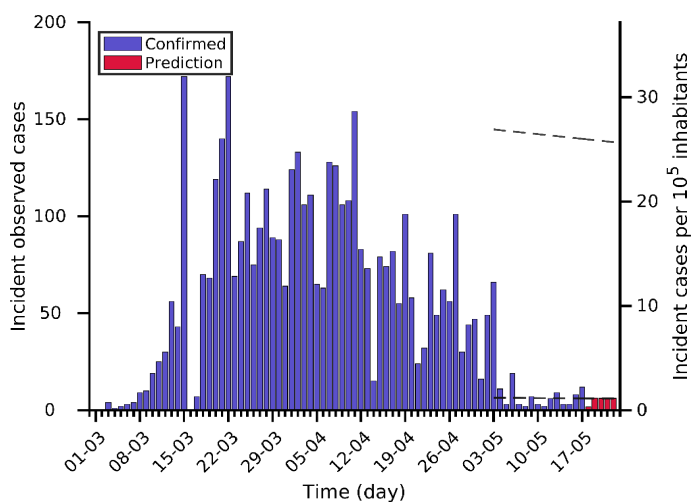
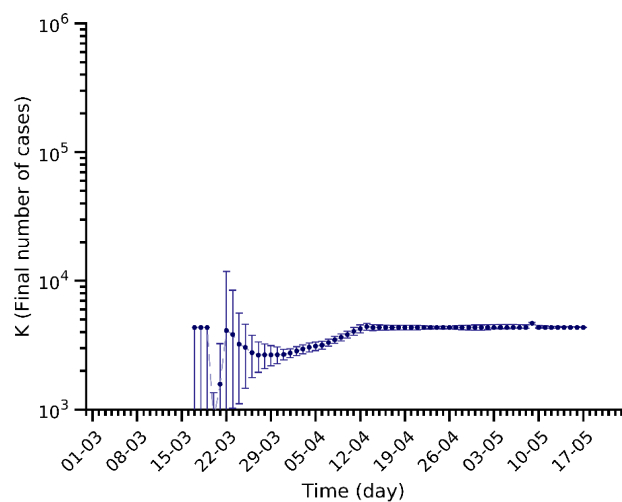
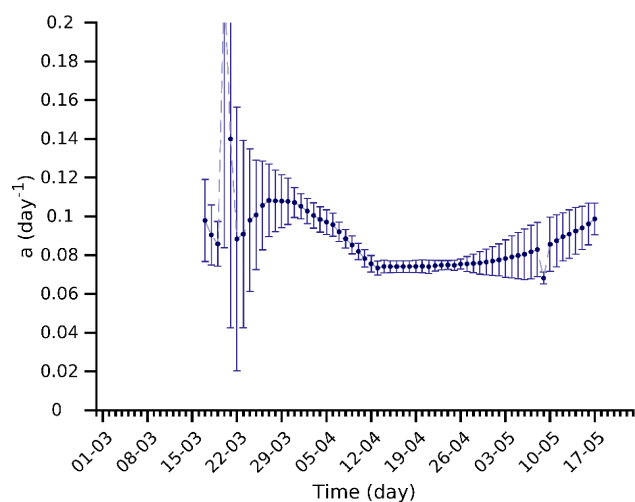
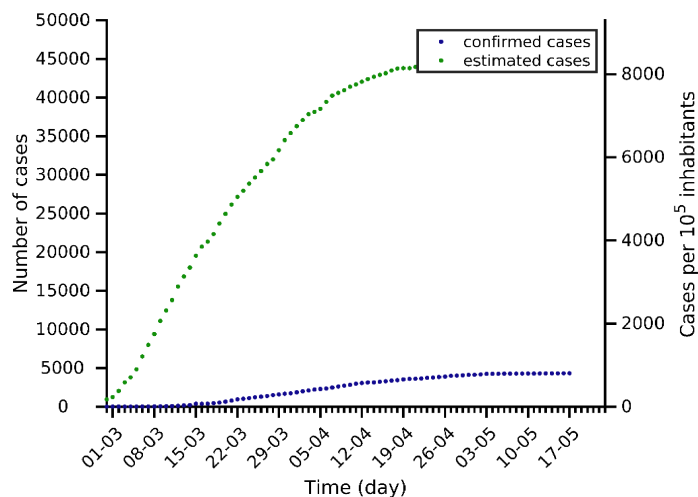
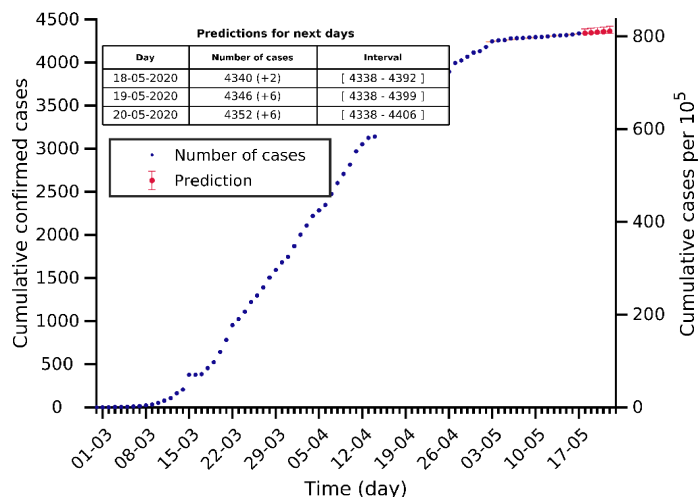
Campania 17-05-2020. Population: 5.8M. Current cumulated incidence: 81/10⁵



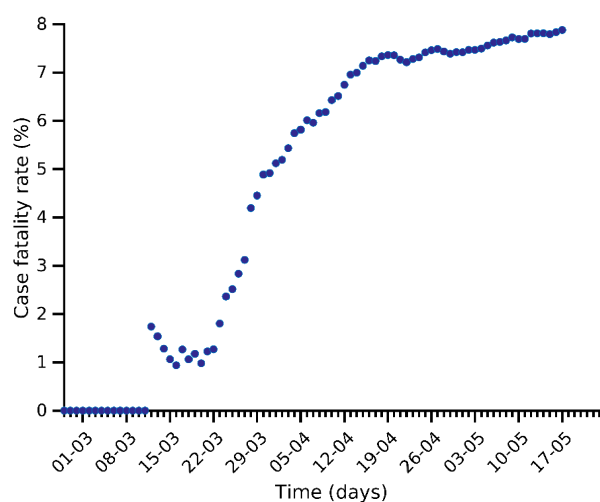
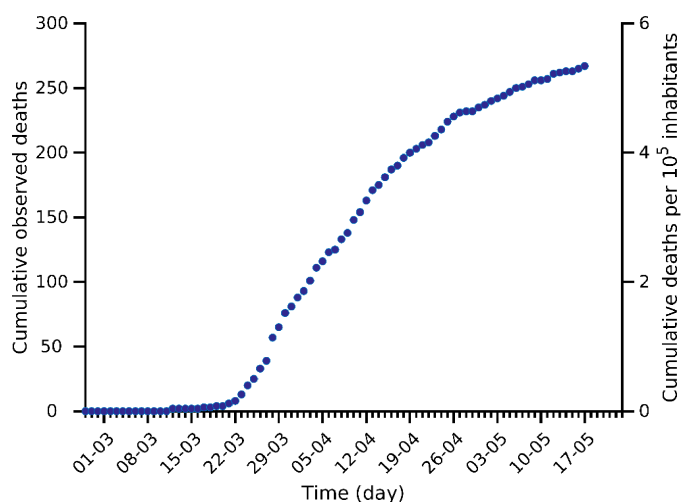
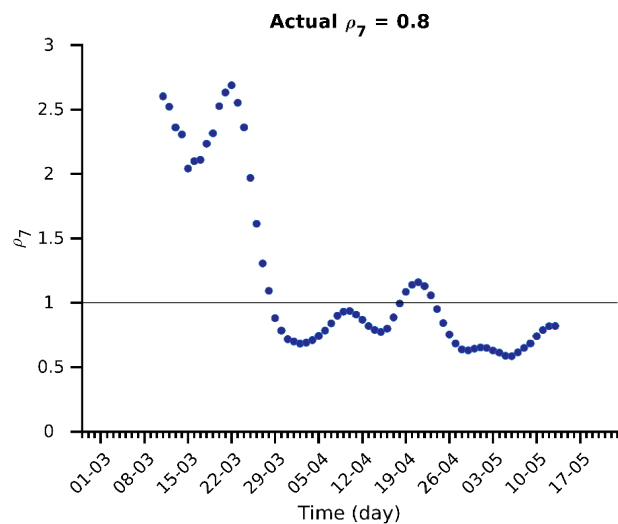
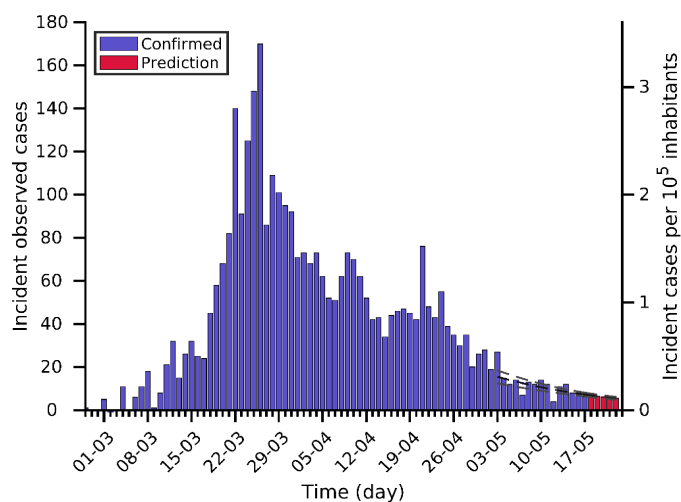
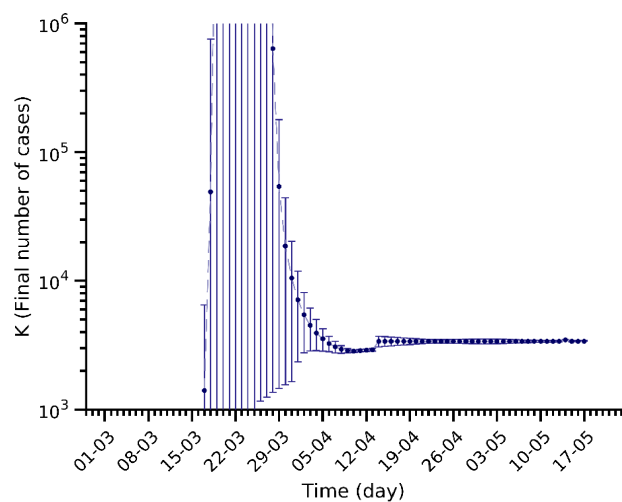
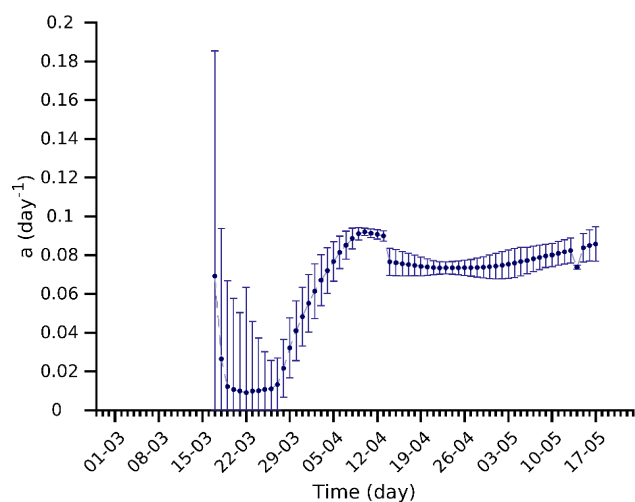
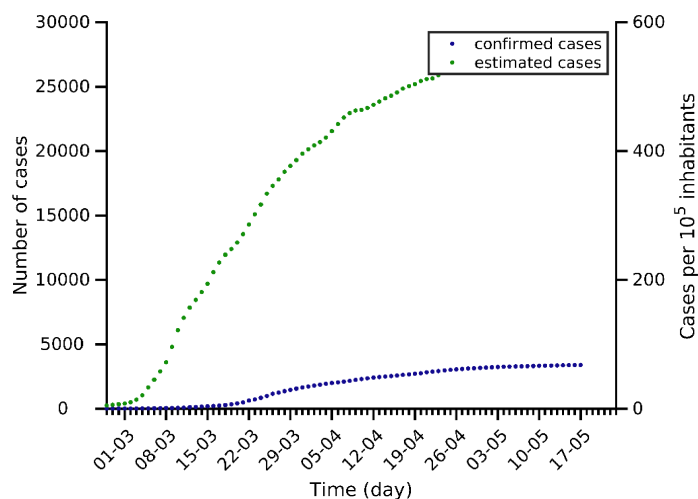
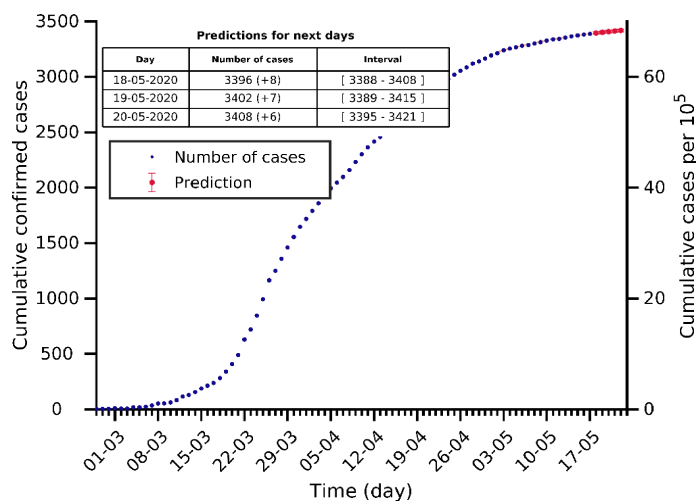
Puglia 17-05-2020. Population: 4.0M. Current cumulated incidence: 109/10⁵



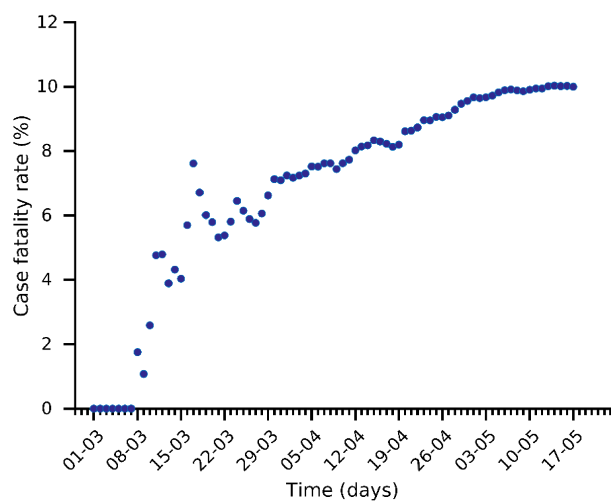
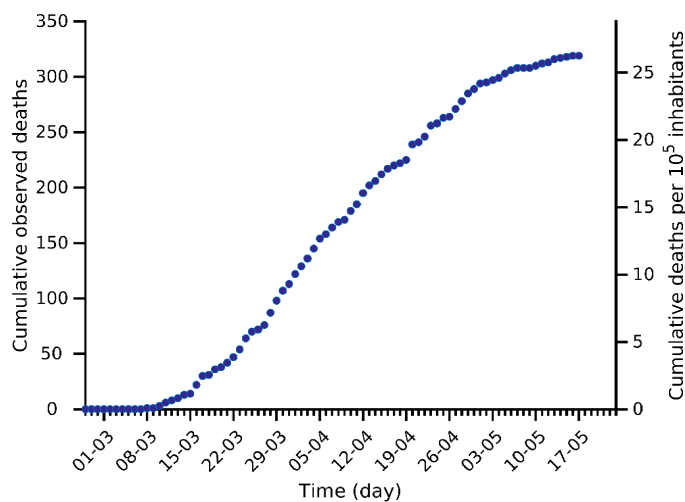
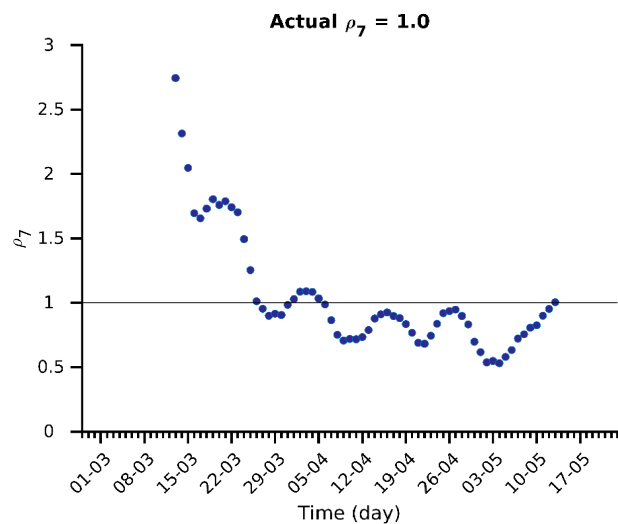
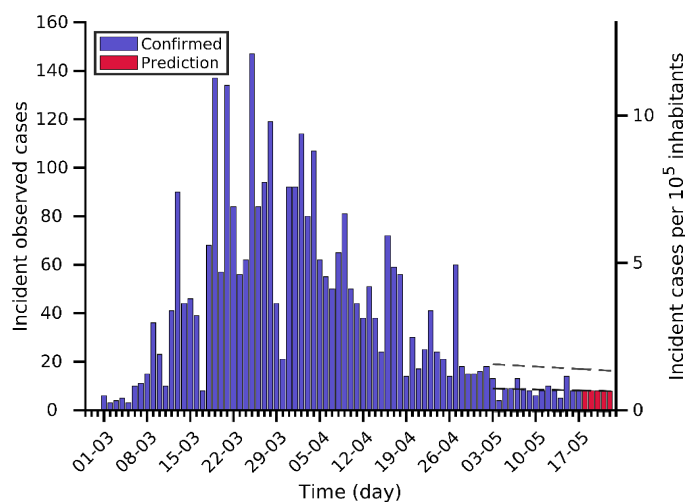
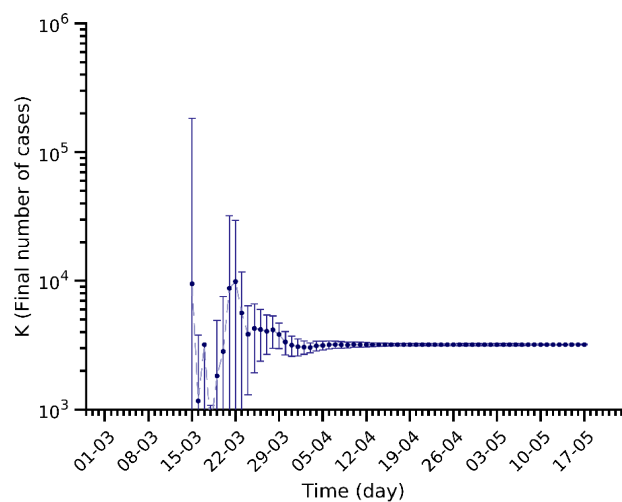
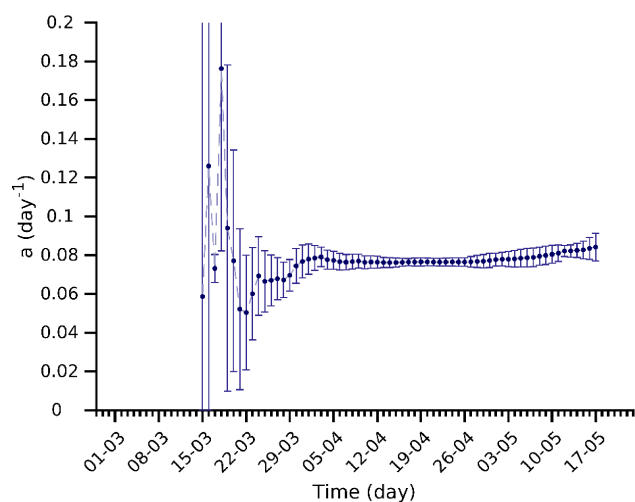
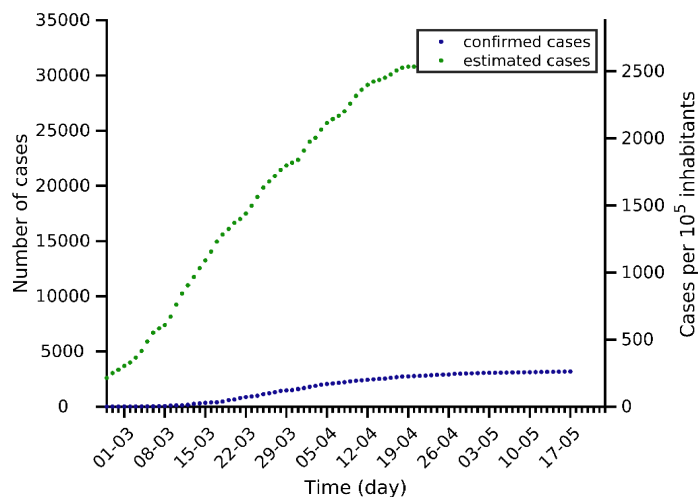
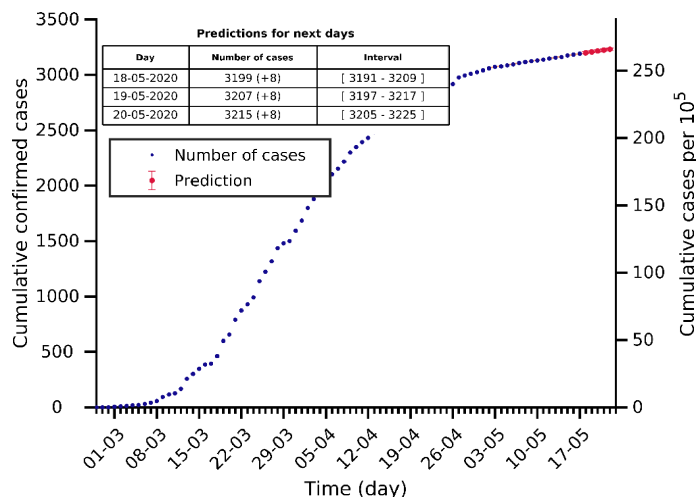
Trento 17-05-2020. Population: 0.5M. Current cumulated incidence: 806/10⁵



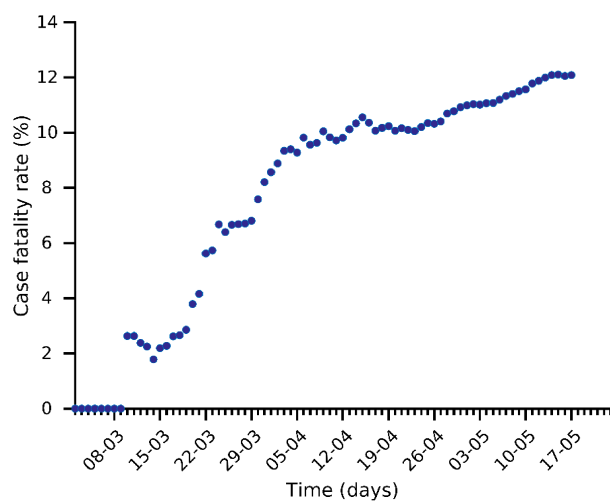
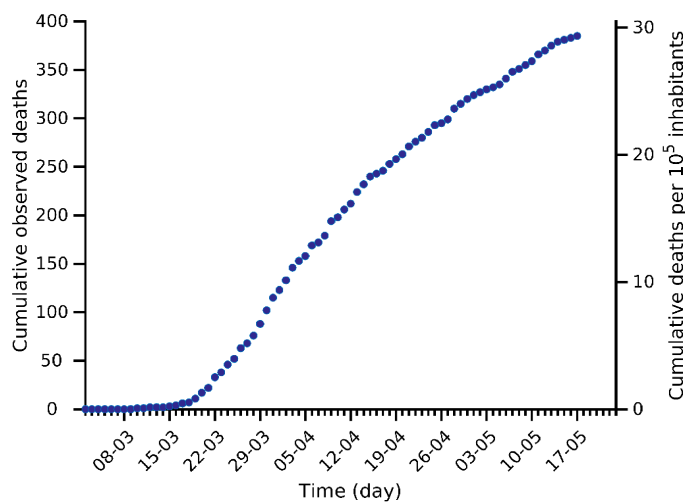
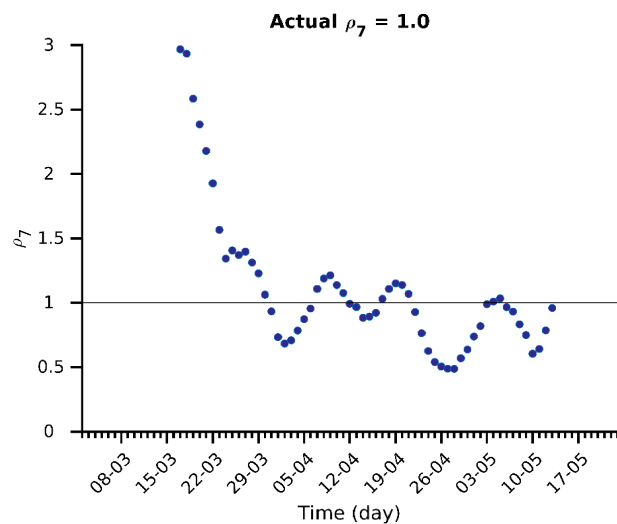
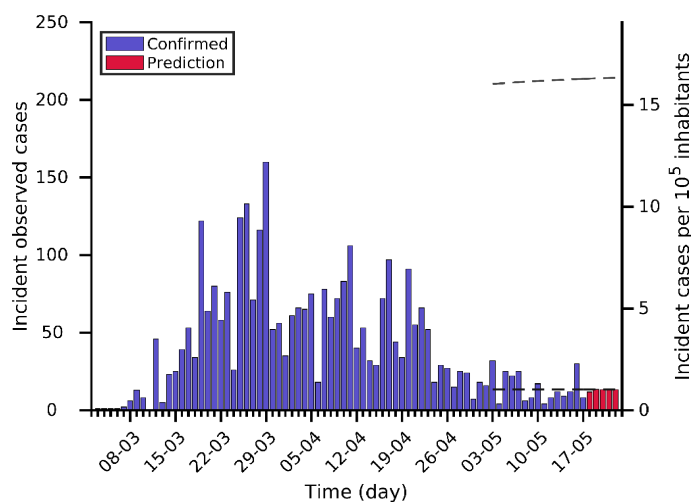
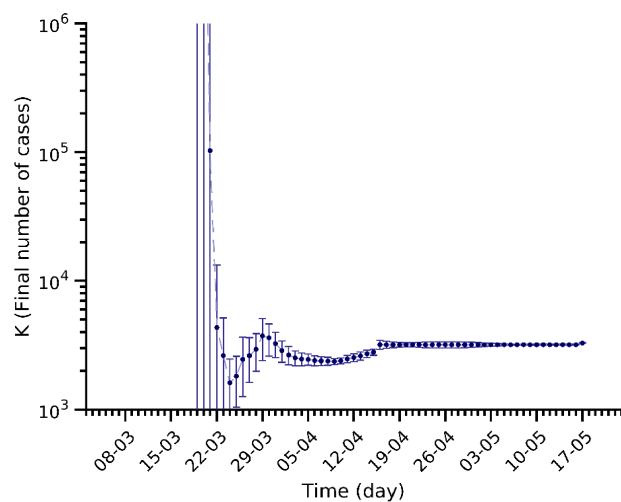
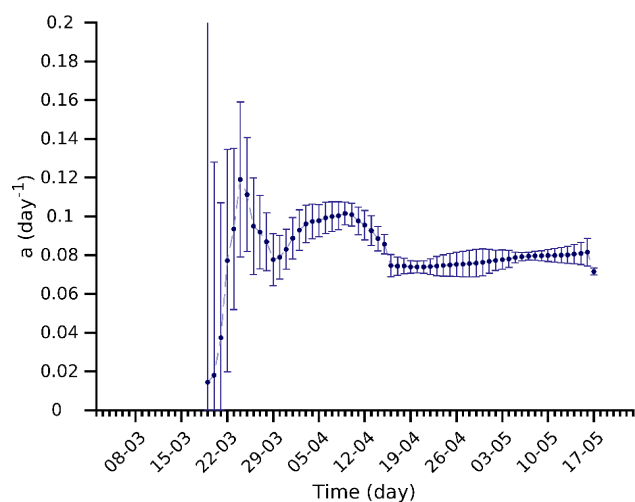
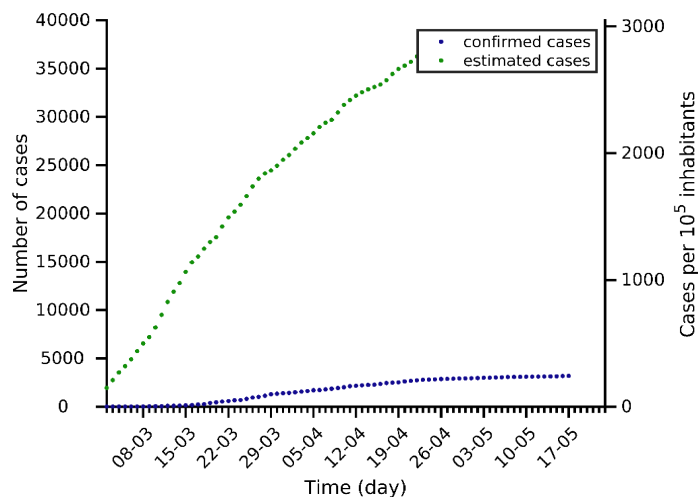
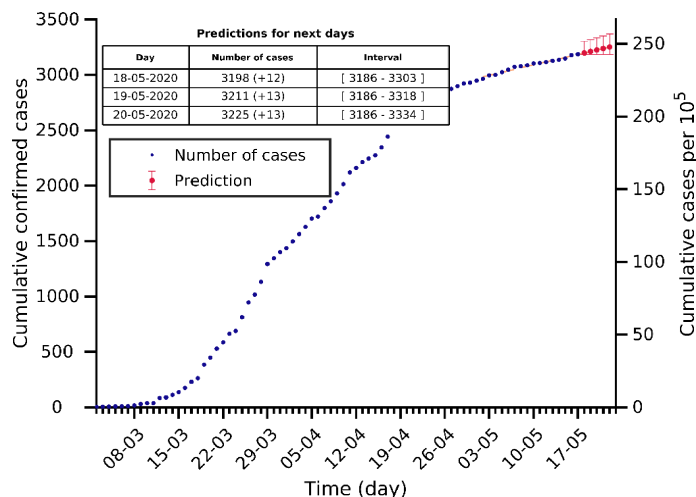
Sicilia 17-05-2020. Population: 5.0M. Current cumulated incidence: 68/10⁵



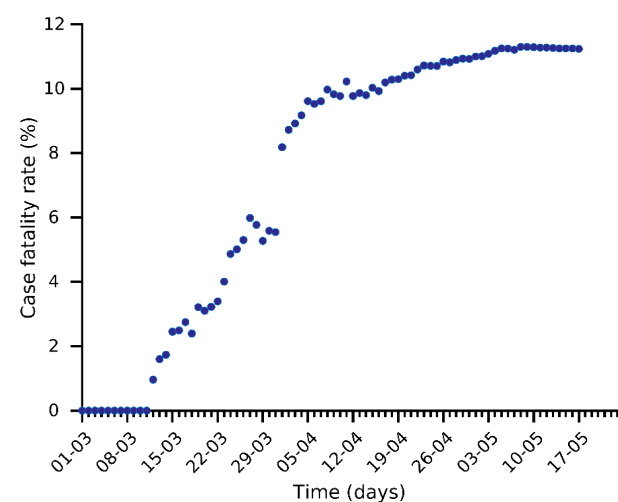
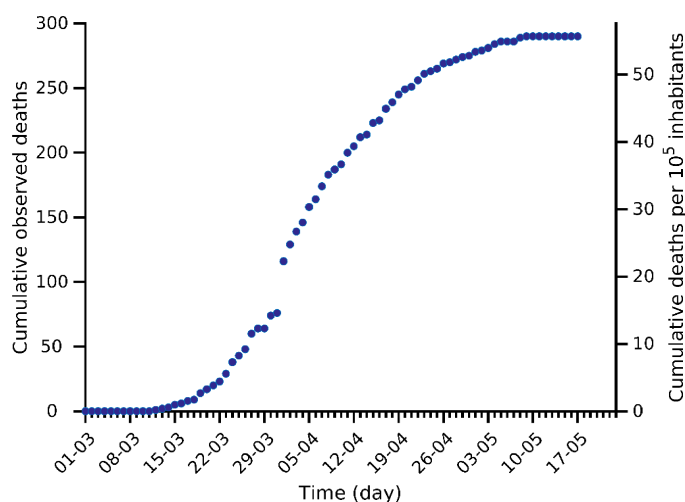
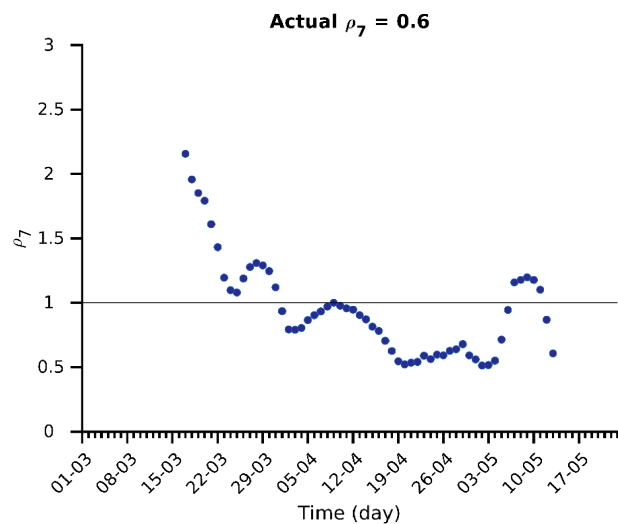
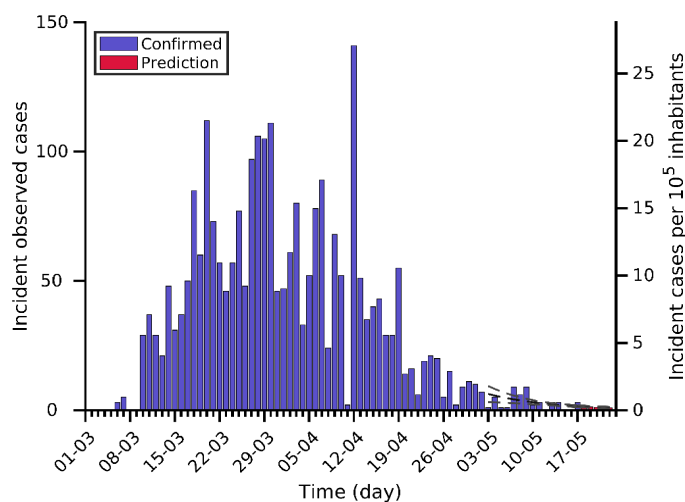
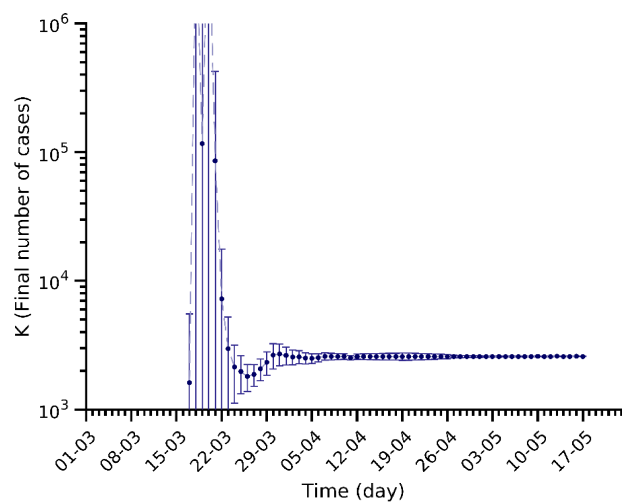
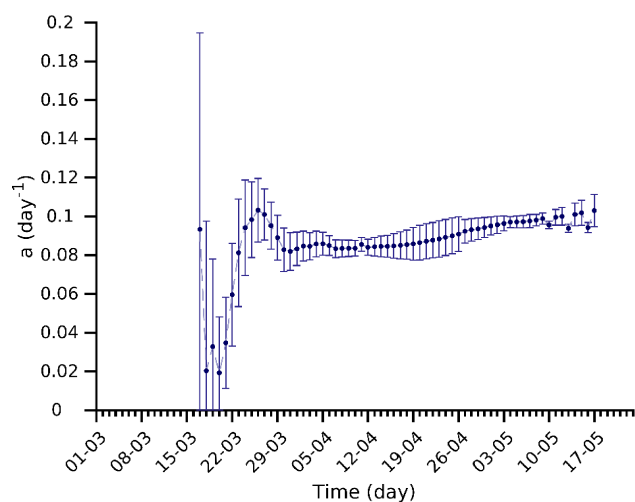
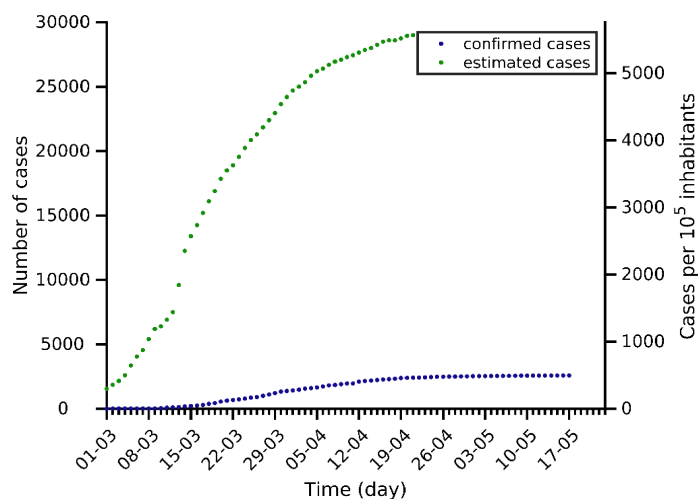
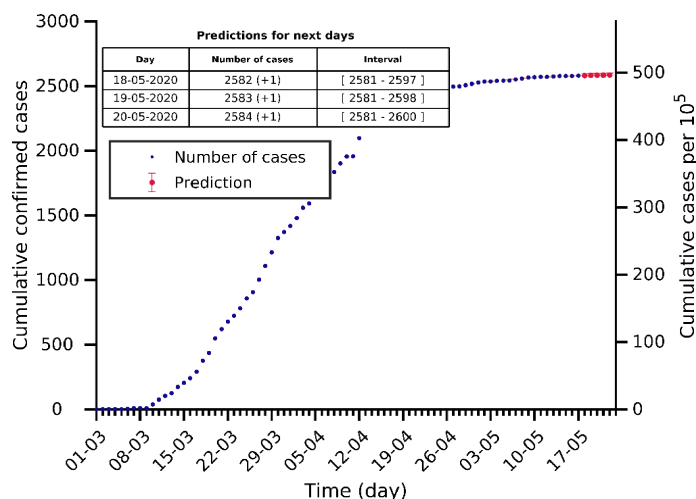
Friuli Venezia Giulia 17-05-2020. Population: 1.2M. Current cumulated incidence: 2



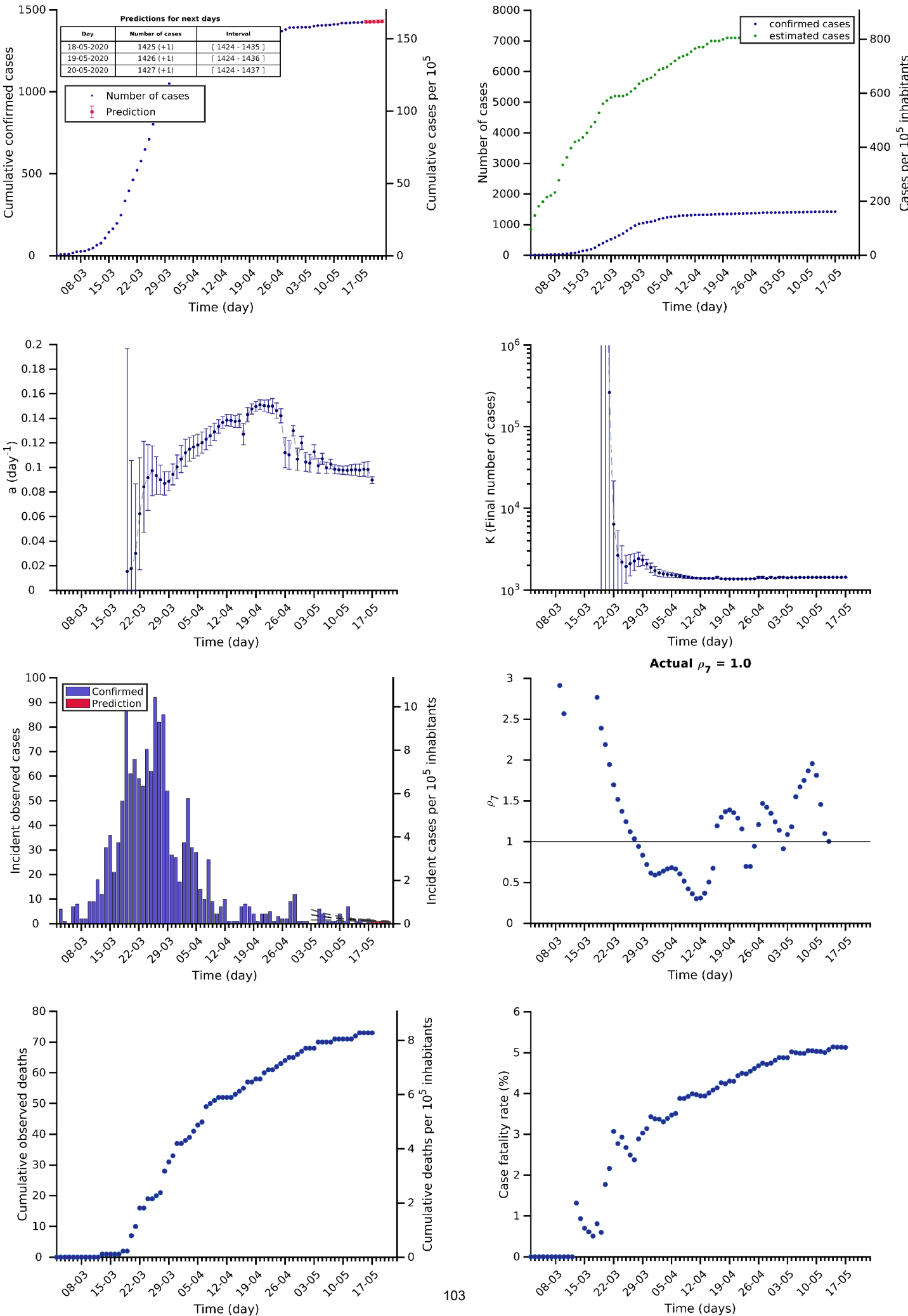
Abruzzo 17-05-2020. Population: 1.3M. Current cumulated incidence: 243/10⁵



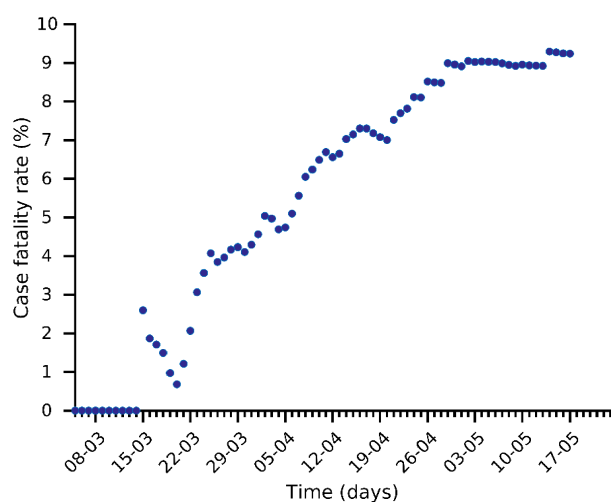
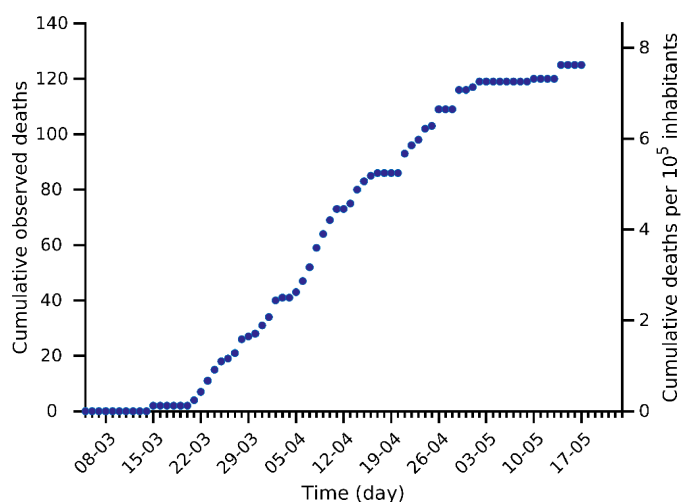
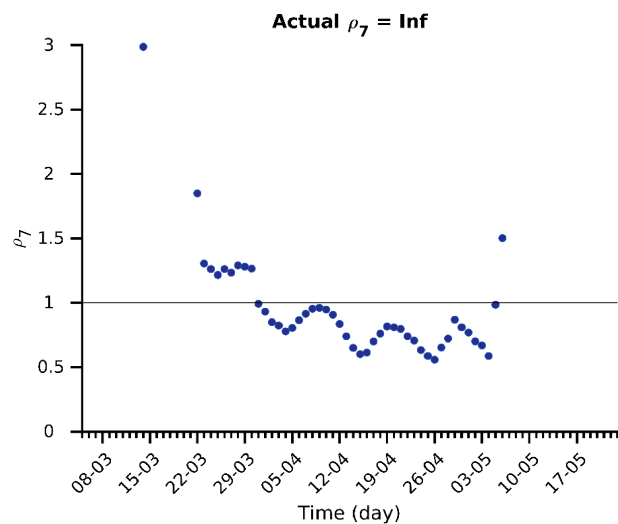
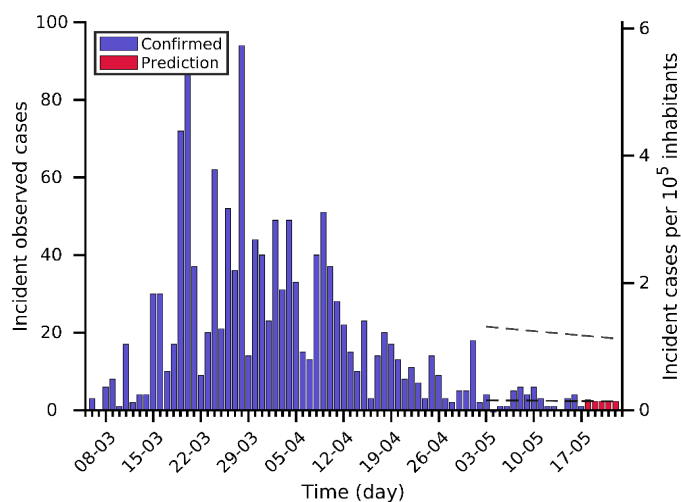
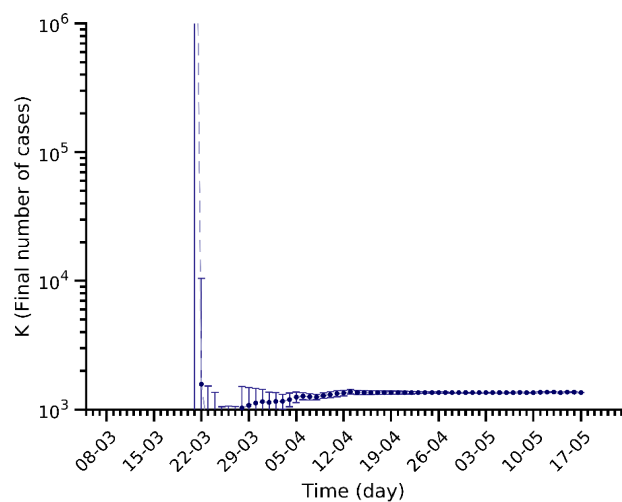
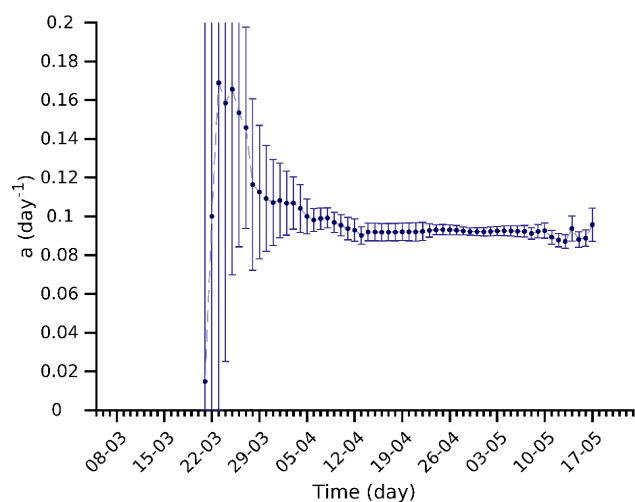
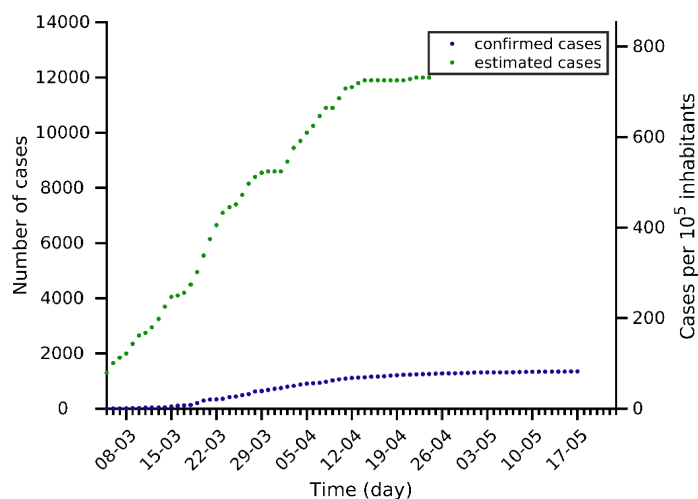
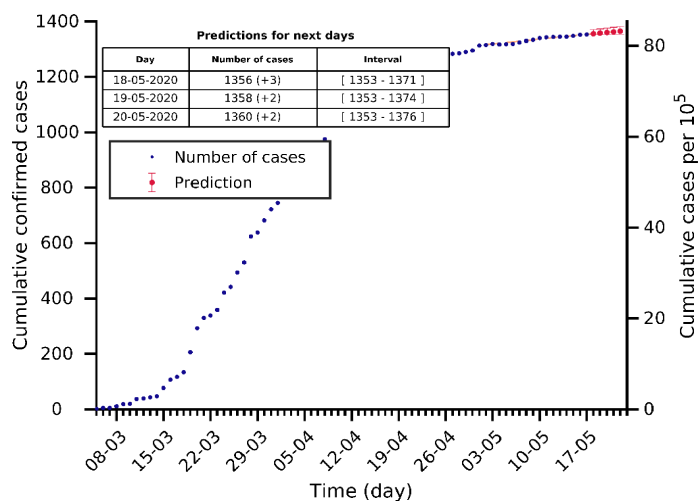
Bolzano 17-05-2020. Population: 0.5M. Current cumulated incidence: 495/10⁵



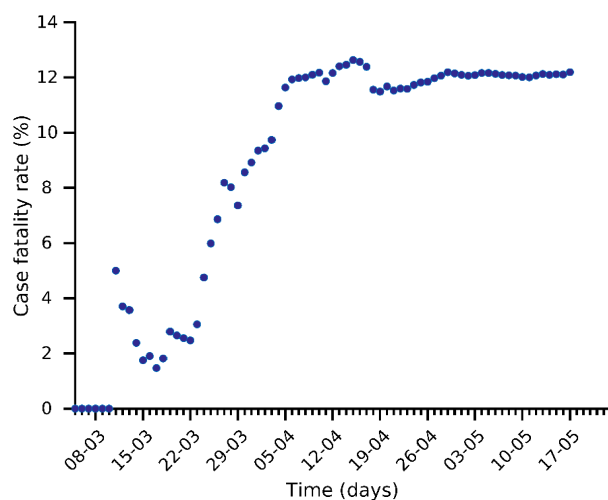
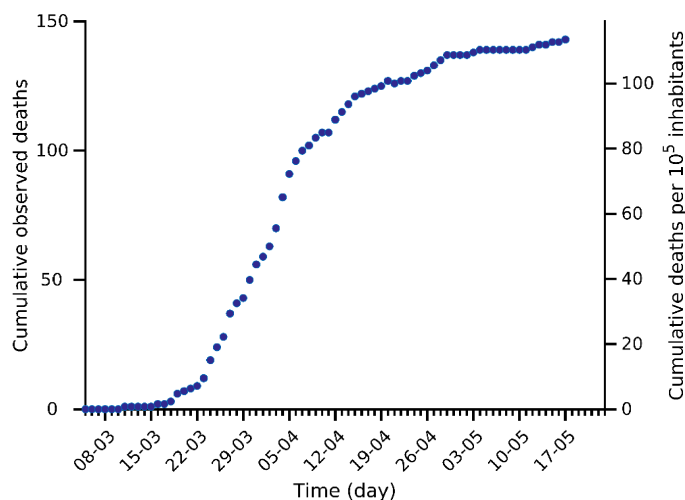
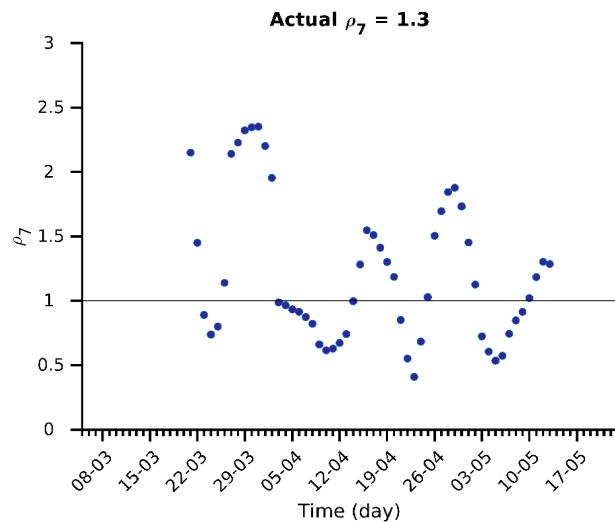
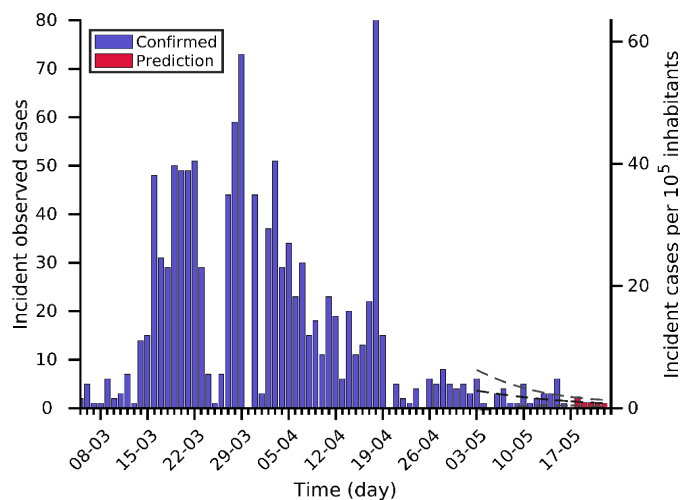
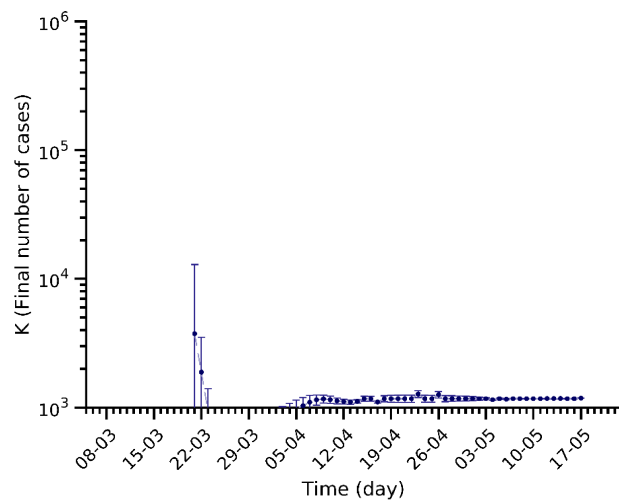
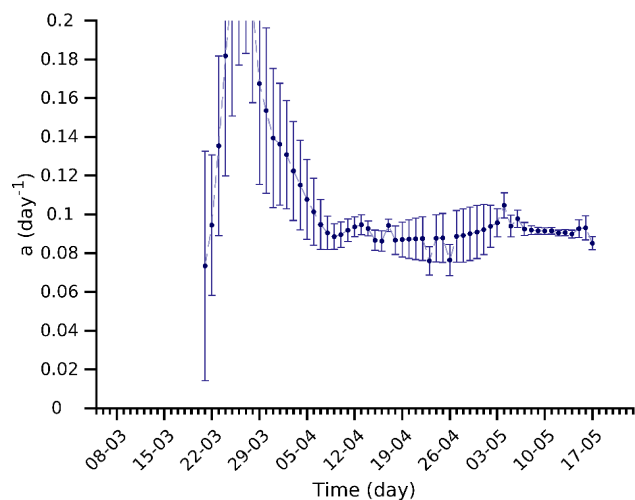
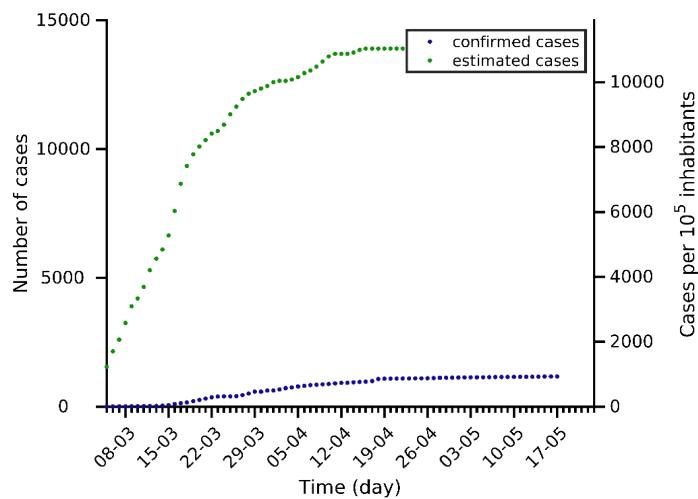
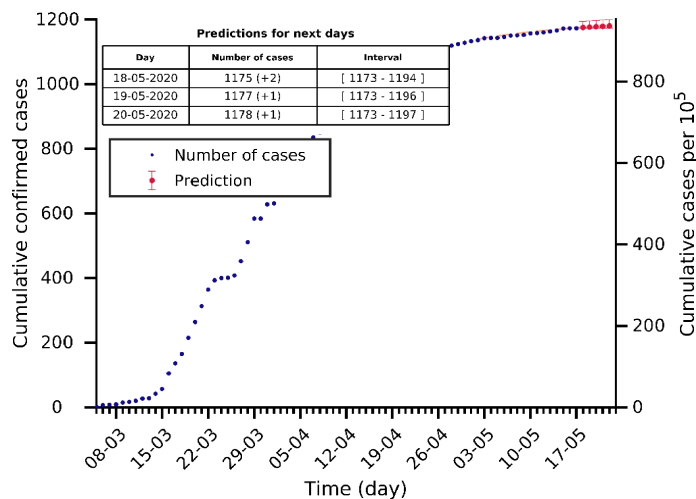
Umbria 17-05-2020. Population: 0.9M. Current cumulated incidence: 161/10⁵



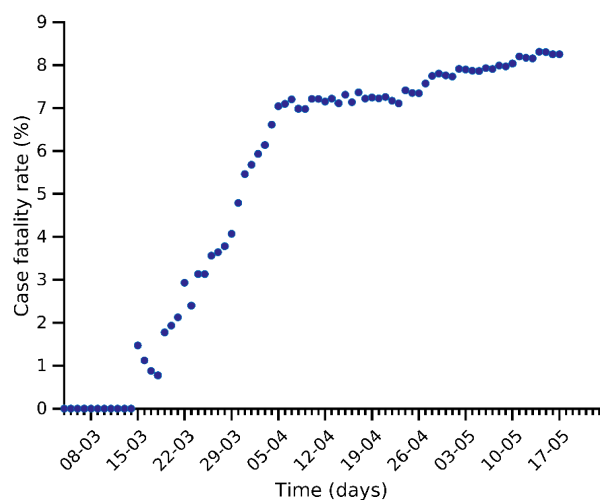
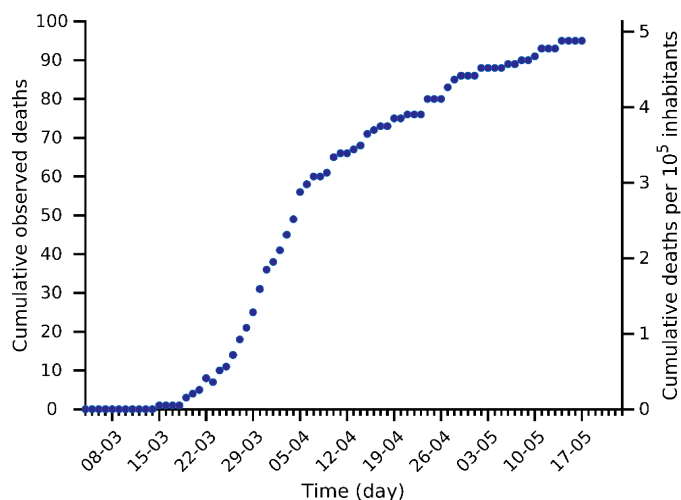
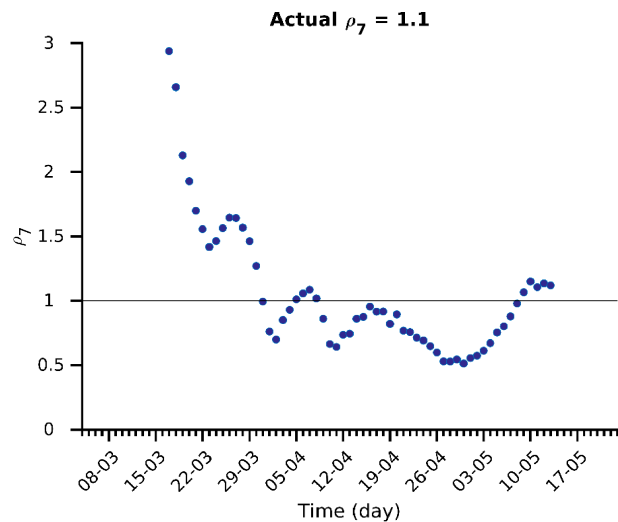
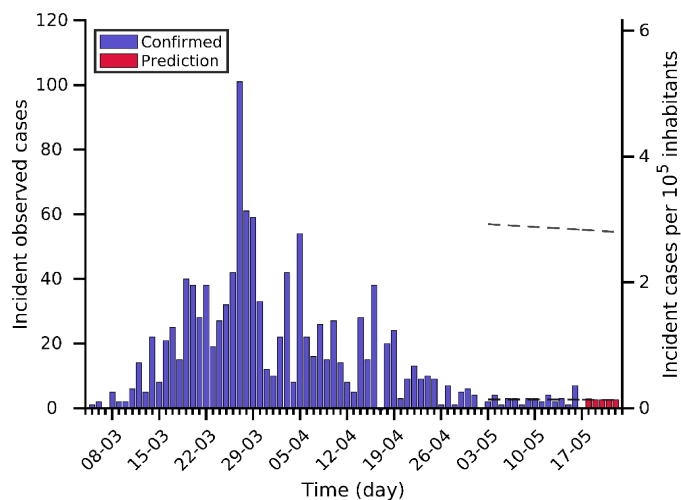
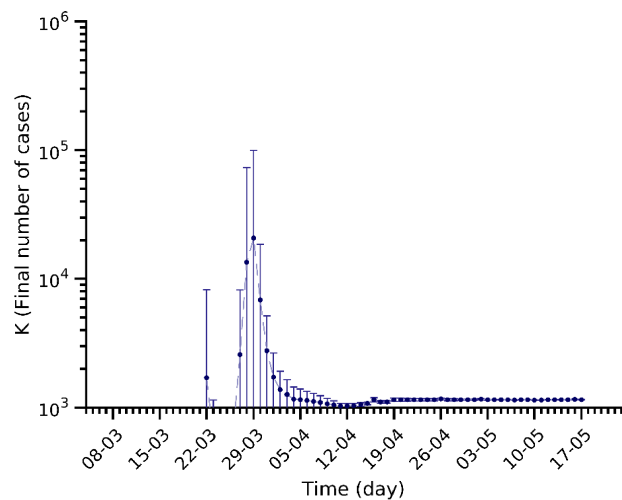
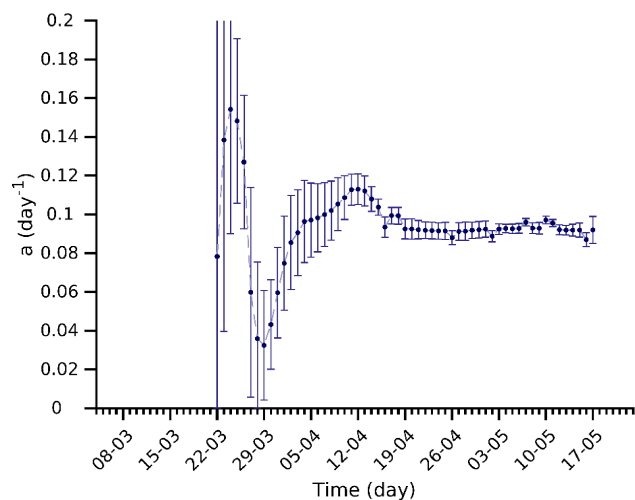
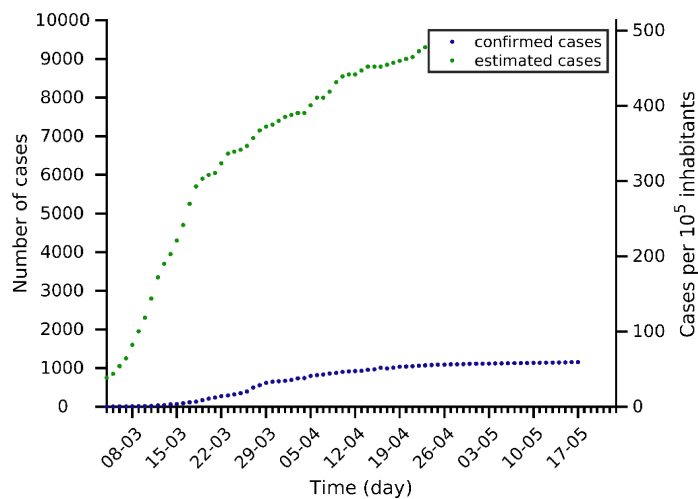
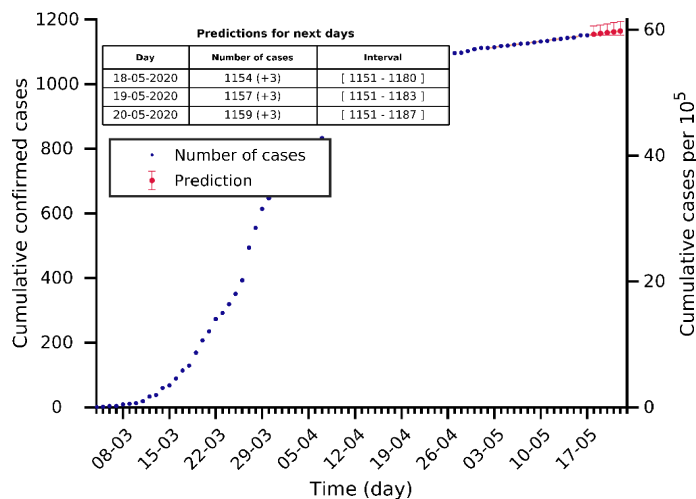
Sardegna 17-05-2020. Population: 1.6M. Current cumulated incidence: 83/10⁵



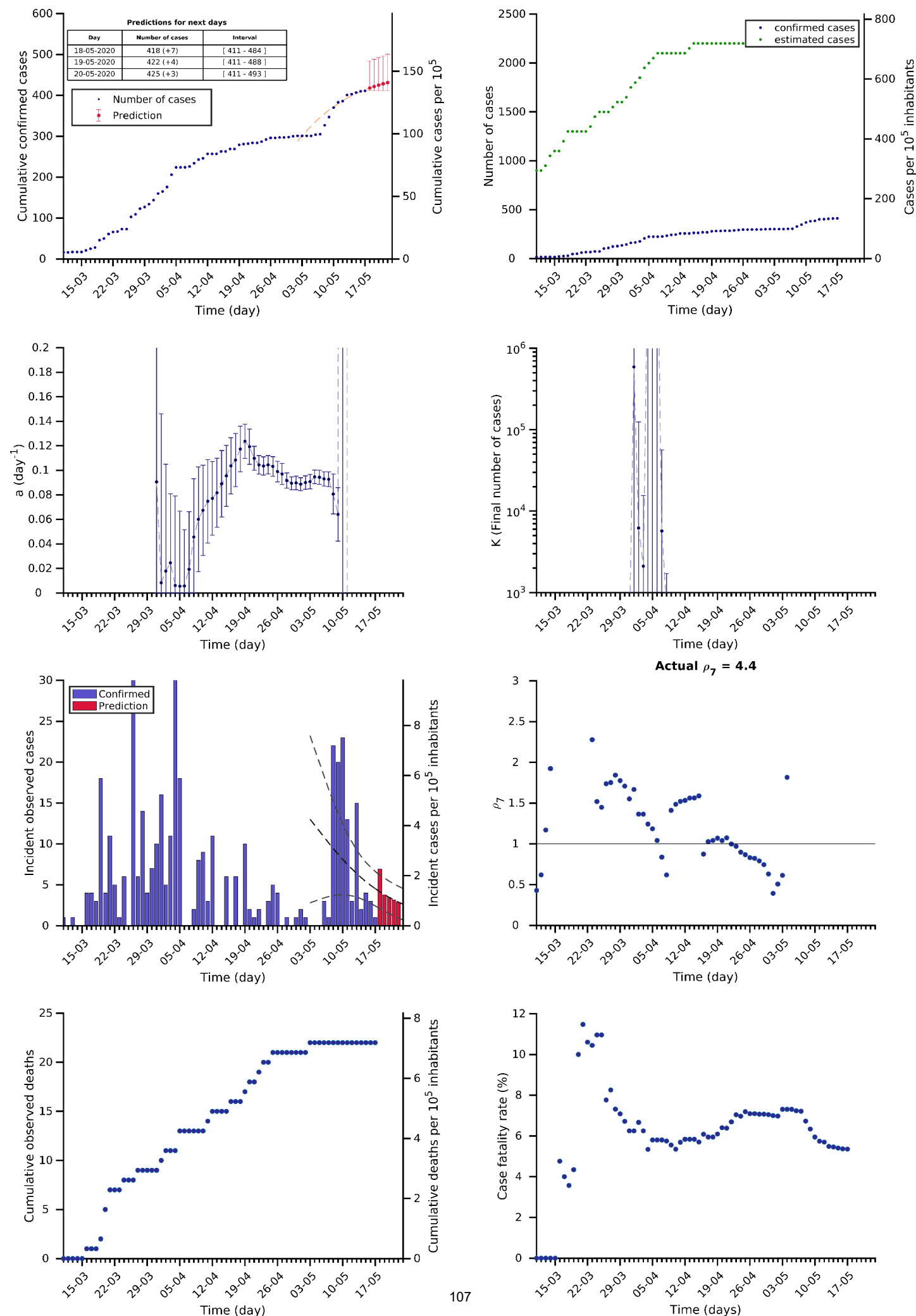
Valle d'Aosta 17-05-2020. Population: 0.1M. Current cumulated incidence: 931/10⁵



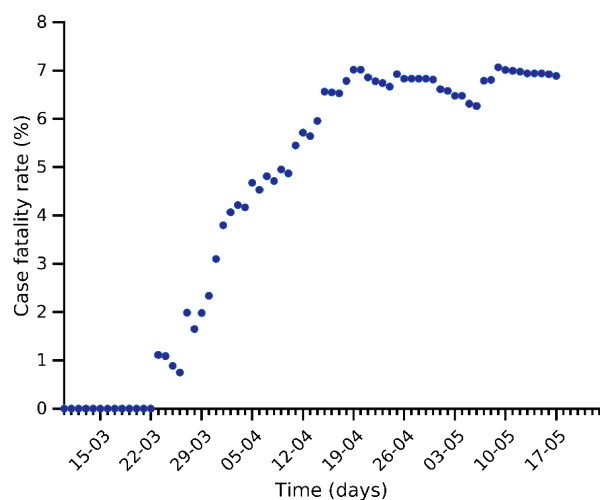
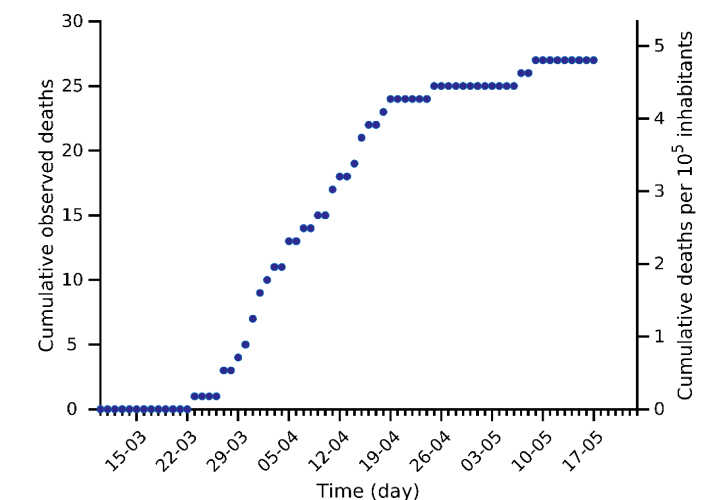
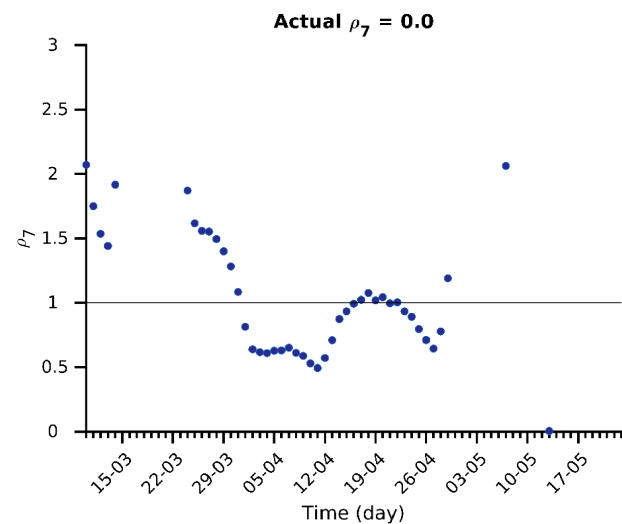
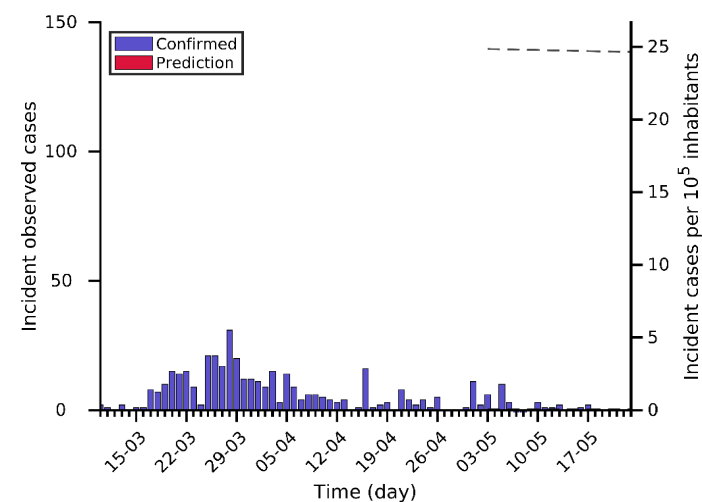
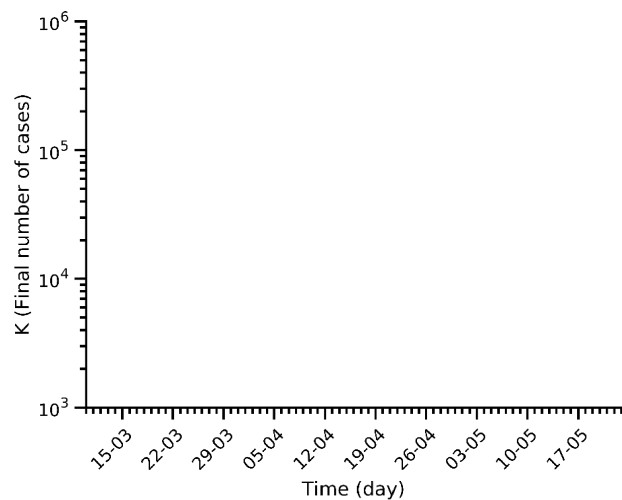
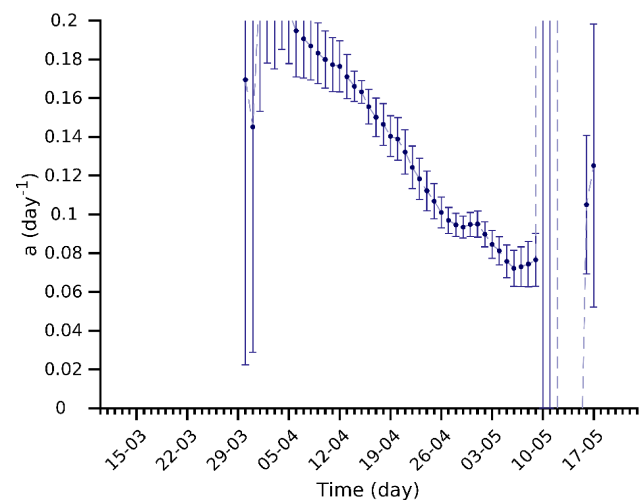
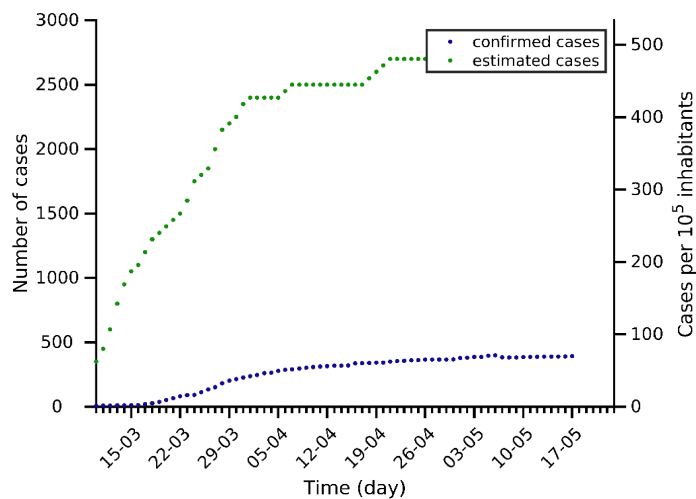
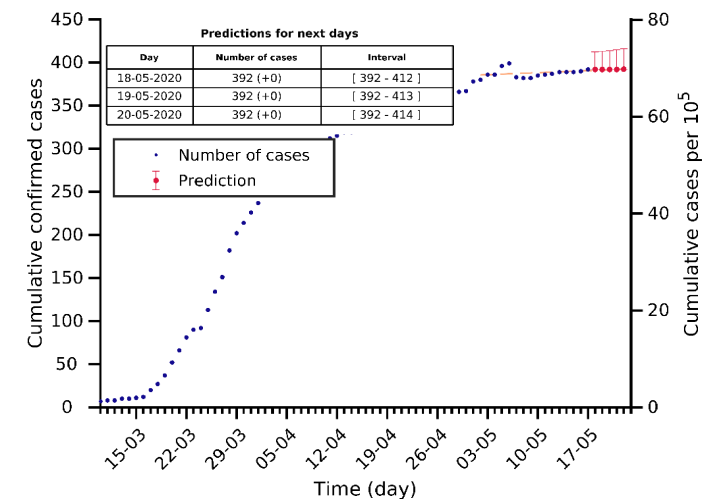
Calabria 17-05-2020. Population: 1.9M. Current cumulated incidence: 59/10⁵



Molise 17-05-2020. Population: 0.3M. Current cumulated incidence: 134/10⁵



Basilicata 17-05-2020. Population: 0.6M. Current cumulated incidence: 70/10⁵



Methods

Methods

(1) Data source

Data are daily obtained from World Health Organization (WHO) surveillance reports¹, from European Centre for Disease Prevention and Control (ECDC)² and from Ministerio de Sanidad³. These reports are converted into text files that can be processed for subsequent analysis. Daily data comprise, among others: total confirmed cases, total confirmed new cases, total deaths, total new deaths. It must be considered that the report is always providing data from previous day. In the document we use the date at which the datapoint is assumed to belong, i.e., report from 15/03/2020 is giving data from 14/03/2020, the latter being used in the subsequent analysis.

(2) Data processing and plotting

Data are initially processed with Matlab in order to update timeseries, i.e., last datapoints are added to historical sequences. These timeseries are plotted for EU individual countries and for the UE as a whole:

- ✓ Number of cumulated confirmed cases, in blue dots
- ✓ Number of reported new cases
- ✓ Number of cumulated deaths

Then, two indicators are calculated and plotted, too:

- ✓ Number of cumulated deaths divided by the number of cumulated confirmed cases, and reported as a percentage; it is an indirect indicator of the diagnostic level.
- ✓ ρ : this variable is related with the reproduction number, i.e., with the number of new infections caused by a single case. It is evaluated as follows for the day before last report ($t-1$):

$$\rho(t-1) = \frac{N_{new}(t) + N_{new}(t-1) + N_{new}(t-2)}{N_{new}(t-5) + N_{new}(t-6) + N_{new}(t-7)}$$

where $N_{new}(t)$ is the number of new confirmed cases at day t .

(3) Classification of countries according to their status in the epidemic cycle

The evolution of confirmed cases shows a biphasic behaviour:

- (I) an initial period where most of the cases are imported;
- (II) a subsequent period where most of new cases occur because of local transmission.

Once in the stage II, mathematical models can be used to track evolutions and predict tendencies. Focusing on countries that are on stage II, we classify them in three groups:

- Group A: countries that have reported more than 100 cumulated cases for 10 consecutive days or more;
- Group B: countries that have reported more than 100 cumulated cases for 7 to 9 consecutive days;
- Group C: countries that have reported more than 100 cumulated cases for 4 to 6 days.

¹ <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>

² <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

³ <https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm>
<https://github.com/datadista/datasets/tree/master/COVID%2019> , <https://covid19.isciii.es/>

(4) Fitting a mathematical model to data

Previous studies have shown that Gompertz model⁴ correctly describes the Covid-19 epidemic in all analysed countries. It is an empirical model that starts with an exponential growth but that gradually decreases its specific growth rate. Therefore, it is adequate for describing an epidemic that is characterized by an initial exponential growth but a progressive decrease in spreading velocity provided that appropriate control measures are applied.

Gompertz model is described by the equation:

$$N(t) = K e^{-\ln\left(\frac{K}{N_0}\right) \cdot e^{-a \cdot (t-t_0)}}$$

where $N(t)$ is the cumulated number of confirmed cases at t (in days), and N_0 is the number of cumulated cases the day at day t_0 . The model has two parameters:

- ✓ a is the velocity at which specific spreading rate is slowing down;
- ✓ K is the expected final number of cumulated cases at the end of the epidemic.

This model is fitted to reported cumulated cases of the UE and of countries in stage II that accomplish two criteria: 4 or more consecutive days with more than 100 cumulated cases, and at least one datapoint over 200 cases. Day t_0 is chosen as that one at which $N(t)$ overpasses 100 cases. If more than 15 datapoints that accomplish the stated criteria are available, only the last 15 points are used. The fitting is done using Matlab's Curve Fitting package with Nonlinear Least Squares method, which also provides confidence intervals of fitted parameters (a and K) and the R^2 of the fitting. At the initial stages the dynamics is exponential and K cannot be correctly evaluated. In fact, at this stage the most relevant parameter is a . Fitted curves are incorporated to plots of cumulative reported cases with a dashed line. Once a new fitting is done, two plots are added to the country report:

- ✓ Evolution of fitted a with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out;
- ✓ Evolution of fitted K with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out; if lower error bar indicates a value that is lower than current number of cases, the error bar is truncated.

These plots illustrate the increase in fittings' confidence, as fitted values progressively stabilize around a certain value and error bars get smaller when the number of datapoints increases. In fact, in the case of countries, they are discarded and set as "Not enough data" if $a > 0.2 \text{ day}^{-1}$, if $K > 10^6$ or if the error in K overpasses 10^6 .

It is worth to mention that the simplicity of this model and the lack of previous assumptions about the Covid-19 behaviour make it appropriate for universal use, i.e., it can be fitted to any country independently of its socioeconomic context and control strategy. Then, the model is capable of quantifying the observed dynamics in an objective and standard manner and predicting short-term tendencies.

(5) Using the model for predicting short-term tendencies

The model is finally used for a short-term prediction of the evolution of the cumulated number of cases. The predictions increase their reliability with the number of datapoints used in the fitting. Therefore, we consider three levels of prediction, depending on the country:

⁴ Madden LV. Quantification of disease progression. *Protection Ecology* 1980; **2**: 159-176.

- Group A: prediction of expected cumulated cases for the following 3-5 days⁵;
- Group B: prediction of expected cumulated cases for the following 2 days;
- Group C: prediction of expected cumulated cases for the following day.

The confidence interval of predictions is assessed with the Matlab function `predint`, with a 99% confidence level. These predictions are shown in the plots as red dots with corresponding error bars, and also gathered in the attached table. For series longer than 9 timepoints, last 3 points are weighted in the fitting so that changes in tendencies are well captured by the model.

(6) Estimating non-diagnosed cases

Lethality of Covid-19 has been estimated at around 1 % for Republic of Korea and the Diamond Princess cruise. Besides, median duration of viral shedding after Covid-19 onset has been estimated at 18.5 days for non-survivors⁶ in a retrospective study in Wuhan. These data allow for an estimation of total number of cases, considering that the number of deaths at certain moment should be about 1 % of total cases 18.5 days before. This is valid for estimating cases of countries at stage II, since in stage I the deaths would be mostly due to the incidence at the country from which they were imported. We establish a threshold of 50 reported cases before starting this estimation.

Reported deaths are passed through a moving average filter of 5 points in order to smooth tendencies. Then, the corresponding number of cases is found assuming the 1 % lethality. Finally, these cases are distributed between 18 and 19 days before each one.

⁵ At this moment we are testing predictions at 4 days for countries with more than 100 cumulated cases for 13-15 consecutive days, and 5 days for 16 or more days.

⁶ Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet; March 9, doi: 10.1016/S0140-6736(20)30566-3